Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

FEBRUARY 1953

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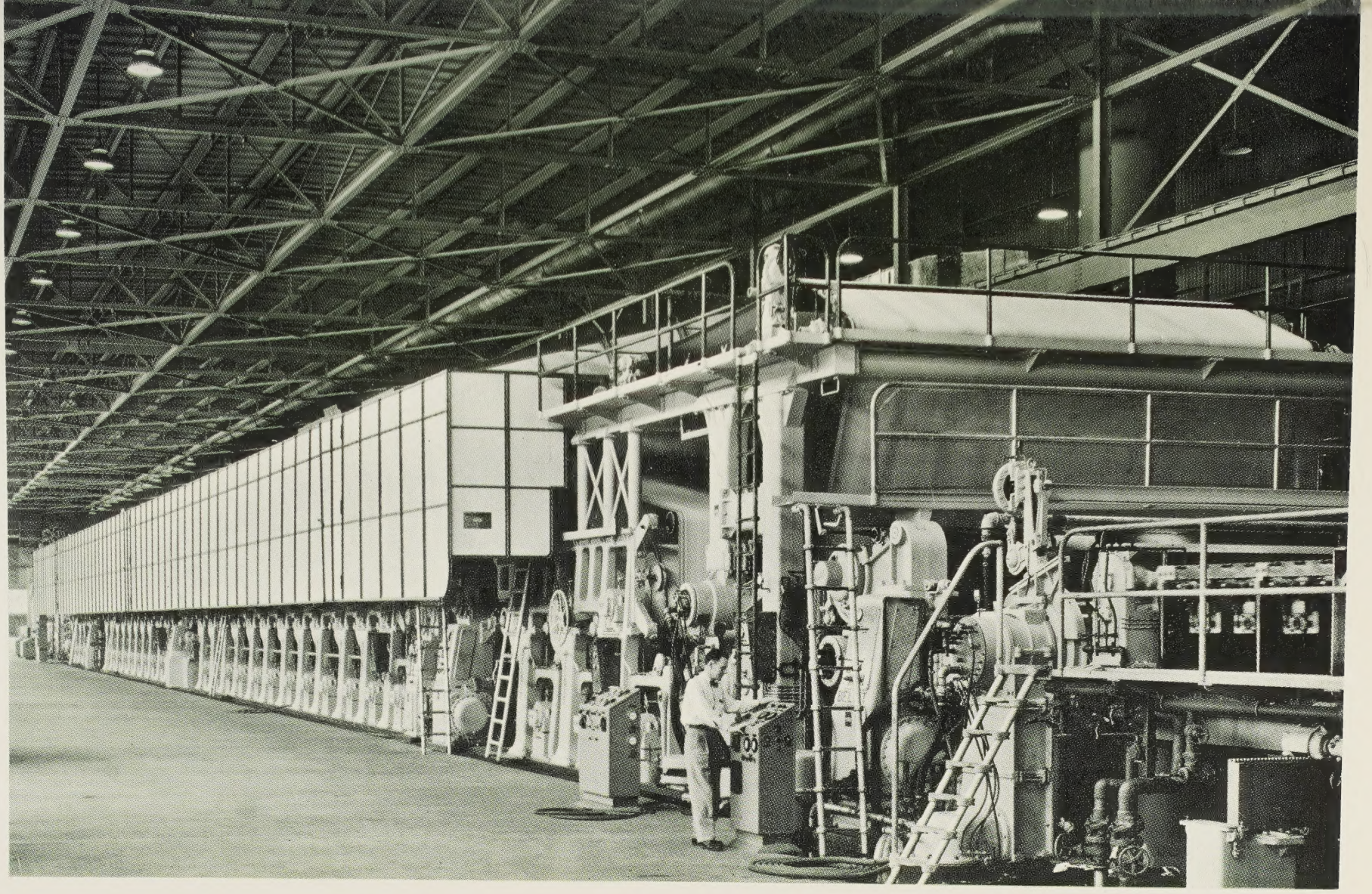

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4. pH	8. Opacity	12. Moisture
		13. Suspension

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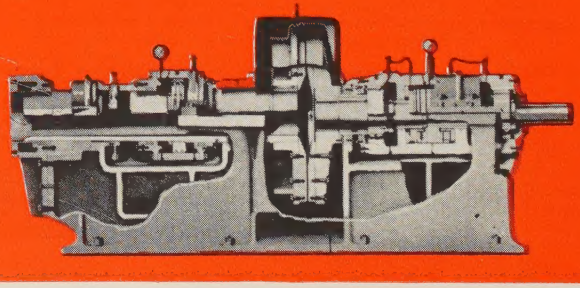
more tonnage
reduced costs
improved quality
greater efficiency

with the

FIGURE 1. A typical Sutherland-treated pulp. Note the length of the fibrils, many of which are still attached to the parent fibers. Thoroughly beaten and refined, the fibers have, nevertheless, not been seriously weakened and chopped up in the process.

FIGURE 2. The effect produced by a Jordan on the same pulp at the same freeness. It can be seen that the fibers have been chopped up into segregated fines, impairing fiber quality and sacrificing many desirable qualities in the finished product

1.



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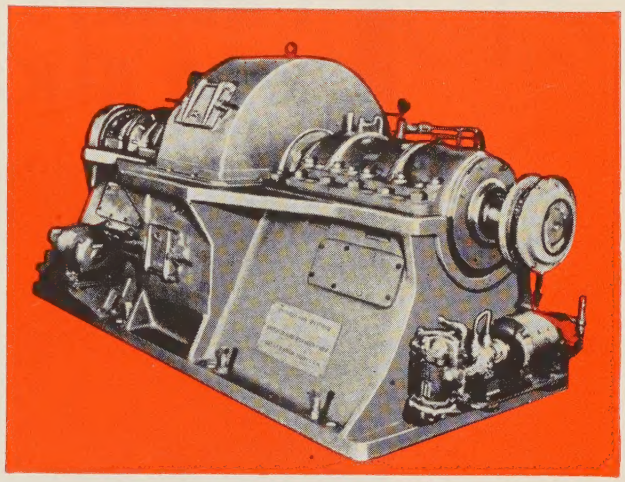

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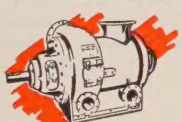

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REDUCED COSTS . . . BETTER QUALITY

Downingtown Fibrepulpers

(*Upper left*) Spiral bevel gear drive requires no special hypoid lubricant . . . is easy to maintain.

(*Left*) General view of three Downingtown Fibrepulpers. Note continuous junk and rag remover which is part of the Continuous Fibrepulper in left foreground.

(*Below*) Showing how scrap paper charge is fed on to conveyors to two Batch and one Continuous Downingtown Fibrepulpers requiring minimum labor.

NEW INSTALLATION AT CERTAIN-TEED PRODUCTS CORP., PRYOR, OKLA., INDICATES ADVANTAGES OF AN INTEGRATED PULPING SYSTEM

The use of Downingtown Continuous and Batch Fibrepulpers, as the illustrations on this page show, results in substantial savings in the handling of stock charges, reduces space requirements and speeds the production of properly prepared pulp for the stock chests. The Downingtown installation at Certain-teed Products Corp. is designed to provide stock for a top liner, filler and bottom liner on a Downingtown modernized seven cylinder board machine.

In addition to the advantages shown here, by specifying Downingtown Fibrepulpers, efficiency and quality are increased through more uniform pulping, higher freeness, controlled fineness and faster pulping cycles.

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FROZEN FOODS

E. W. WILLIAMS

THERE are today 1280 frozen food packers or processors of commercially frozen vegetables, concentrates, fruits, poultry, seafoods, meats, and specialties.* In 1945 there were about 400. Packers are the backbone of the industry; percentage-wise they break down into the following categories: vegetable and fruit packers, 34% of the total, concentrators, 4%, seafoods, 33%, meats and poultry, 15%, and specialties, 14%. However, the percentage of packers in a given category bears no relation to volume; i.e., concentrators, numbering only 4% of all packers, did, in 1951, about 20% of total dollar volume.

Most vegetable and fruit packers are medium size, that is producing between 5 and 15 million lb. of merchandise or doing a gross volume between 1 and 3 million dollars yearly. While the packer's percentage of profit has gone down during the past 5 years, volume has been up so substantially that the profit outlook for the future seems much brighter. Fruit and vegetable packers averaged in 1950 and 1951, 4.8% gross profit on net sales.

Recent experience shows that some staple frozen food items become short before the new packing season. Plant expansion is inevitable. During the next 24 months more freezing, processing, storage, packaging, and transportation facilities will be needed.

Great advances in harvesting have taken place in the frozen foods industry in recent years which tend to put the packing industry on a more economical, mass production basis. Field labor costs have been reduced and the time from field to package has been shortened.

In pea harvesting, for instance, peas are now cut and loaded directly onto trucks in one operation. Lima beans, once considered a luxury, are now on a par with peas in price because of mechanical harvesting. Spinach, too, can now be cut and loaded onto trucks in one operation. Corn can also be mechanically harvested. Berries are being mechanically harvested experimentally.

The big trend continues to be toward the retail package and during the past year an increasing quantity of frozen vegetables have been siphoned off from the institutional package into new, grade B lines.

More and more frozen vegetable and fruit production is marshalled under the "name" brands such as Birds Eye, Snow Crop, Libby, Honor Brand, PictSweet, Seabrook, Blue Goose, Dulany, Cedergreen, and sectional brands such as Flav-R-Pac, Year Round, Frostcraft, Little America, Dewkist, Fairmont, Booth, Fair Acres, "19c," Garden Gate, Southland, Winter Garden, Top Frost, several chain brands and others. Over 80% of fruit and vegetable packers today act as "feeder" plants to keep nationally or sectionally advertised brands supplied. However, a QFF survey of medium sized packers (November, 1951) demonstrated a strong spirit of independence among frozen food packers; 69% reported that they still pushed their own brands but would retain buyers' labels as a hedge. It therefore seems that the total number of brands, despite the greater flow of products to national brands, has increased rather than decreased.

During 1950 and 1951 the frozen foods industry made remarkable gains in both sales and production. At no time since 1946 has there been a really adverse inventory position in staple frozen food items. With the continued impact from (1) more vigorous chain and super-market merchandising, (2) more cabinet placements in stores, (3) continued competitive pricing of frozen foods, (4) increased volume through second grade "economy" lines, a considerable increase in plant and processing equipment is expected.

Present plant capacity on vegetables and fruits alone is equal to a yearly production of between 1.2 and 1.5 billion lb. at peak. Present frozen vegetable, fruit and concentrate consumption is already close to 8 lb. per capita; 1951 frozen vegetable and fruit production was about 1200 million lb. The industry's plant capacity is sailing pretty close to the wind now. A major expansion should be eminent.

There is a distinct trend, too, among packers to broaden operations so that they can work plants as close to a year-round operation as possible. For this purpose, many packers are adding new items all the time, even though these items do not represent broad markets. There should be an increase in these "secondary" products and by the same token, their availability and "exposure" to the public, may also increase their acceptance. In this category are items like okra, blackeye peas, various types of greens, peppers, kale, squash, etc. Other packers are going farther afield to keep plants open and are packing what is available locally—sometimes poultry, seafood or specialty items.

DISTRIBUTION

There are now about 1200 frozen food distributors serving the industry.† Originally most distributors started in the wholesaling of frozen foods as a sideline from an established business; today's many distributors were originally produce houses, dairies, creameries, wholesale grocers, ice cream companies, fish and meat wholesalers and packer operated branches (65% of distributors entered the business since 1939; about 20% since 1944). About 35% of distributors handle nothing but frozen foods. Distributor volume has increased to the point where many dual operations now run frozen foods as an entirely separate department and in some

E. W. WILLIAMS, publisher of *Quick Frozen Foods*, New York, N. Y.

* Source—QFF's Annual 1952 Processors' Directory.

† Source—1951 edition QFF Directory of Wholesale Distributors of Frozen Foods.

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MOLD PROOFING
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230 Park Avenue, New York 17, N. Y.

cases distributors have dropped their original line of business and are now devoting their whole efforts to frozen foods.

Approximately three out of five of the industry's wholesalers now handle two or more lines of frozen foods according to a QFF survey (May, 1951). Three or four years ago there were exclusive frozen food distributors for each well-known brand. Some 56% of multiline distributors queried said they took on lines because they were nationally advertised. On the other hand, 44% ignored advertised labels in favor of price lines.

Because of increasing sales by chains, first one frozen food packer, then another began selling direct in certain territories. Many smaller packers followed suit. While some packers go direct because they are compelled to yield to chain store pressure or are forced to do so to safeguard their competitive position in chain store cabinets, others acknowledge a preference for the wholesale operation.

It is possible that the swing to direct selling may complete its cycle and at least partially return to the wholesaler again. One remedy seems to be the dual pricing system which provides all buyers with one price if delivered and another price if the merchandise is picked up at the warehouse. Many packers now operate on such an "ex-warehouse" price.

Whereas three or four years ago practically 100% of retail package frozen food distribution was effected by wholesalers, today this has dropped to perhaps 65 to 70%. However, so great has volume sales of the average distributor increased that today he is doing a bigger volume business than he ever did, despite the loss of some chain accounts.

The local trucking or drayage service has also entered the picture (QFF, January 1951). This is a trucking service direct from warehouse to chains and these, it is claimed, are operated at around 5% of the cost of the products at the packer's price. The trucker's responsibility terminates when the driver sets down the order at a place in the retail store adjacent to the cabinet. Cases are generally not split below a dozen. The direct trucking deal does not include the advantages which local frozen food distributors can offer both in service and inventory, but in some cases it seems to fill the need for certain large chain buyers.

During the past 2 years, frozen food distributors have greatly improved their operations through the introduction of more efficient methods such as rearrangement of sorting rooms, improved inventory control, introduction of IBM systems and more efficient order taking and billing procedures. All this, together with increased volume, has drastically reduced mark-ups to a point where many distributors in larger areas today operate on an over-all mark-up of between 12 to 14%. In more rural areas where stops are fewer and volume lower, mark-ups range up to 24%. On fruits and vegetables, for instance, recent figures indicate that 31% of distributors work under 20%; 33% between 20 to 23%, and 36% up to 24% mark-up.

On concentrates, 54% of distributors are charging 20% mark-up from gross. On frozen seafoods it is about 20% and on poultry and meats it is generally under 20%. On frozen specialties, 54% of distributors mark up to 24%.

Most distributors are developing independent store and institutional business. The average distributor handles a longer list of products than ever before; 100% handle frozen fruits and vegetables, 90% concentrates, 65% poultry, 62% seafoods, and 60% a sizable line of specialities and meats.

Distributors today are generally in a better financial condition than they were 5 years ago. This is due mainly to increased volume and the weeding out of many shaky operations. Despite rather violent changes in the frozen food distribution system during the past three years—and with perhaps more to come—the progressive distributor's future today is satisfactory. For he is a part of the growing frozen food industry and with adequate management he cannot help but grow with it.

The average over-all retail mark-up in small stores is 20 to 27%. In chains it breaks down as follows: vegetables and fruits, 23.4%; concentrates, 20.8%; poultry, 17.5%; meats, 20.8%; seafoods, 23.5%, and specialities, 26.3%.

So great today is the volume of frozen food products offered for sale that retailers are necessarily selective because cabinet space is limited. This has resulted in the "battle of the brands" for cabinet space which continues to an increasing degree. Special sales are frequent and will continue to become more so in the future as the jockeying for selling position in various markets goes ahead. Most frozen foods are no longer considered a semiluxury, but a staple. The consumer buys leading vegetables, concentrates, and to a degree, poultry, seafoods, and some specialities as she does soaps, sugar, and other necessities. This means frequent cut-pricing on such items as frozen peas, spinach, beans, strawberries, and orange juice concentrate.

There is a trend toward the decentralization of cabinets in stores (QFF, December, 1951). A position near the produce department is favored by many stores, the theory being that since frozen foods are competitive with fresh produce, maximum sales are secured when the two departments are placed side by side; also produce clerks can service the cabinet. Others prefer the frozen food cabinet next to the meat department; still others near the dairy department or check-out counter.

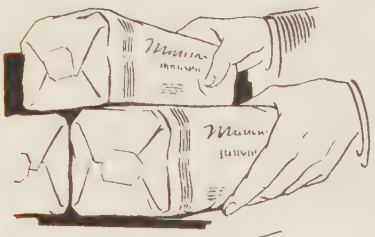
Many stores are now decentralizing cabinets, that is, spotting a juice cabinet in one part of the store, the fruit and vegetable cabinet in another, poultry and meats elsewhere, and still another cabinet for seafoods and specialties. Another type of store prefers to build up its frozen food sales by concentrating all cabinets in one department. Whatever the tendency, however, the complete frozen line is now too big to be encompassed in one cabinet for any store intending to do even a fair volume. At least three to four cabinets are now needed to do a job.

Locker Plants

There are now about 11,000 locker plants in the U. S. Years ago, QFF described the locker operator as a cross between a retailer, a small processing plant, and a warehouse. It was then a "new kind of animal." The locker industry reached its peak in 1944 when net income average between $4.00 and $4.66 per locker (QFF, June, 1951). After 1947 the demand for lockers lessened and processing volume declined. This resulted in sharply lowered net earnings—only 57¢ per locker for 1949 and about the same in 1951.

Butchers...

Bakers...



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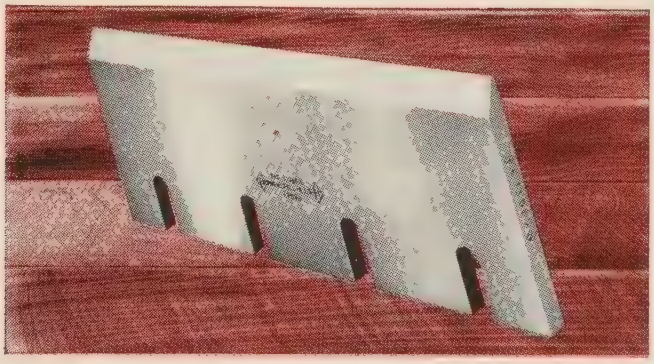

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There are, however, over 3 million lockers in use and this, together with the zero holding rooms in locker plants, represents a considerable reserve of low temperature space throughout the country, especially in rural areas. The rural locker plant represents an economic necessity for farmers and townspeople; in more urban centers, however, locker plants are developing into larger retailers and subdistributors for frozen foods.

Locker operators are becoming increasingly interested in frozen foods as a means of increasing sales which presently are limited to locker rentals, meat processing and other minor types of services. The operator has obviously been neglected as a merchandiser of case lots of frozen foods to patrons who rent lockers. Some operators sell home freezers and have some control over the delivery of foods to these units.

Many locker plants of today will develop into frozen food centers in the future. As such, they represent good bases for (1) the distribution of frozen products in rural areas, (2) the sale and servicing of frozen foods to home and farm freezers, (3) retailing of case lots to locker renters. The growth of the locker field will probably be stabilized around 10 to 11,000 plants.

RETAILING

Approximately 220,000 stores now have some facilities for handling frozen foods. There are 495,000 retail food outlets of all types in the U. S., so obviously there is still considerable room for expansion. The real bottleneck, however, is in cabinets; there are simply not enough cabinets per store.

The average independent retailer does from $3000 to $5000 per year in frozen food volume. Chains and large supers are now averaging 3.8% of their total store volume in frozen foods (QFF, November, 1951). This is against 2 years ago when the average sale was 1.6%. Some stores do up to 7%.

It is estimated that over 90% of chains and 60% of independents carry frozen foods. Vegetables, fruits, and concentrates have 100% distribution in both large and small stores, seafood items, 97% distribution in large stores and 93% in smaller ones; poultry, 100% in large and 83% in small stores; meat, 67% in large and 55% in small stores and specialties, 70% in large and 58% in smaller outlets.

The position of the chain in frozen food distribution has become very important, especially since 1949. It is estimated that over 50% of frozen food sales are now made through chain stores. A national concentrator has stated that 70% of all concentrate sales are now being made through chains; 37% through several large national systems, and 33% through regional and sectional chains.

Cabinet space in chains is growing; average lineal feet of cabinets in large stores in 1951 was 26 ft., compared to 23 ft. the year before; for smaller stores, 15 ft. compared to 12.5 ft. A 1950 survey also showed that 35% of chains warehoused frozen foods; in 1951 this has climbed to 53%.

House-to-house distributors are now to be found in many communities. At present there are approximately 30 of such operations in the country. Their growth and economic justification rests squarely upon the increasing placement of home freezers. So far, these

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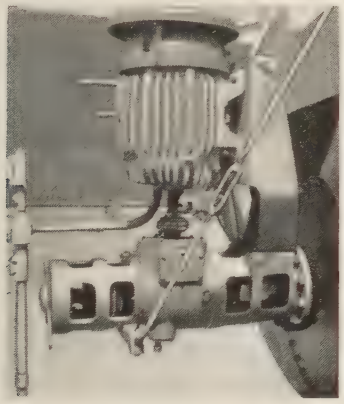

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operations have not been too profitable but volume has grown appreciably from an average sale of $5.00 per stop in 1945 to $25 to $50 per stop today.

Another growing factor is the close hook-up between the sale of home freezers and frozen foods (which QFF has advocated for many years). This is now emerging in the form of a radio program in New York and some other big cities in which a nutrition expert speaks several times a week about "a new way of life"—frozen foods. Inquiries are invited and the salesman calls on the prospect with a plan to sell a home freezer stocked with an assortment of food and a further plan to keep the unit supplied regularly. The plan is available to apartment dwellers as well as suburbanites.

Several years ago lockers were installed in the basements of apartment houses. This movement, as soon as the apartment shortage loosens up, should come back. The time may come when landlords will offer lockers as an integral part of housing, just as refrigerators and stoves are taken for granted today.

PRICES, COSTS, AND FINANCING

According to a QFF survey (QFF, December, 1951), frozen food prices at retail declined 3.9% in most of 1951 as against a similar period in 1950 for 14 leading items. Of all foods, frozen products have held the line against inflation and much of their increased popularity is due to the fact that prices have been kept moderate. As against frozen food prices, the Bureau of Labor Statistics Index of other food prices shows a steady increase.

During the past 2 years, during the greatest inflationary food price rise in recent history, the frozen foods industry has operated at deflationary prices. This has been due to intensive competition and the fear of being caught with unsold inventories. Actually, the inventory position of the industry today is good and it now looks as if many staple items are becoming short before the next packing season. Perhaps the industry has not had sufficient confidence in its selling prowess.

Of course there are distinct costs connected with producing and distributing a product which must be handled at zero temperatures. Many packers do not know or understand their actual costs and have suffered from the lack of sound accounting systems. This has helped occasionally to upset the whole market, especially in California. Just how much frozen food prices can be increased depends in a large measure on the market for the industry's competitive counterparts —fresh and canned products. But even to a greater degree, prices depend on (1) rate of movement, (2) competition *within* the industry.

The "battle of the brands" is just beginning. Competition for the still limited cabinet space is keen. These two facts, plus the constant struggle against retailer inertia, will tend to keep frozen food prices down; the growing sales of second grade merchandise will also prevent disproportionate rises in A grade prices.

The frozen foods industry, though in better financial shape than ever before, is still seriously underfinanced. There is need for pumping money into the industry as a whole. Some packs have been unnecessarily curtailed because of inadequate financing. The financing of cabinets is sorely needed; a liberal system for the immediate placement of cabinets in stores, available to both packers and distributors, would do more at the moment to relieve this long recognized bottleneck than anything else. Recently, however, some large cabinet manufacturers have come forth with a choice of several plans which offer long-range, easy financing.

Inventory loans and the availability of working capital are two of the industry's most constant needs. I. R. Bean of the Bank of America (QFF, November, 1951), estimates that a frozen food processor's investment in plant facilities should average about $5.00 per 100 lb. of food packed each year. He also states that the "insurmountable obstacles" of a few years ago have been overcome and that most packers are now good credit risks for loans.

While the working capital requirements may change under varying circumstances, one source of information indicates that the small freezer who packs to confirmed orders and carries a minimum inventory operates satisfactorily on $12 to $15 per $100 of sales.

On the other hand, larger packers who maintain inventories in, and make deliveries from, key warehouses throughout the U. S., require approximately $25 per $100 of sales.

There is more big money coming into the industry all the time. Recently a new large zero warehouse was finished in Chicago, financed by the Prince interests of Armour & Co. Whitney money helped start Minute Maid and Clinton Industries originally took over Snow Crop. Many large companies today have a growing interest in frozen foods: General Foods, Stokely-Van-Camp, Libby, McNeill & Libby, Swift, Armour, Dole, Welch, Borden, Doughnut Corp., Crosse & Blackwell, Sunkist, Blue Goose, Green Giant, Horlicks and others. Chains, too, are increasing their investment by the adoption of their own frozen food brands, leading chains being Safeway and First National.

The next few years should see the increasing attraction of important capital to the industry.

CABINETS

The bottleneck is still cabinets! No matter how far-flung may be the plans of frozen food sellers—no matter how ambitious their merchandising programs, no matter how attractive and eye-appealing their packages, the sobering fact still remains that there just aren't enough frozen food cabinets in the nation's stores.

Meanwhile the industry's production of new packages has increased far beyond the zero space in stores through which to dispense them. For instance, the fish industry has now twice as many 1-lb. seafood packages as a year ago. The frozen concentrates now on the market are three times those in 1949 and fruit and vegetable packages have increased (by brand and variety), by almost 25% over 1950. Production in 1951 was estimated at $2^1/_2$ billion pounds of which over 60% was in the retail container size.

The average 18-ft. cabinet holds about 700 packages; many of the 220,000 stores handling frozen foods have cabinets of smaller size and while it is true that most new stores opening today install frozen foods and that chains are constantly expanding their cabinet space, the total amount of low temperature cubic footage will be considerable below 1952 frozen food output.

The slowness in placing cabinets can be attributed to the industry, the retailer, and the cabinet manufacturer.

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"South of the border," a 66-ton, B&W Black-Liquor Recovery Unit was ordered recently by Fabrica de Papal de San Rafael y Anexas, S. A., Mexico. The new unit is designed to deliver 31,000 lb of steam per hr at 475 psi and 670 F, and is equipped with automatic-soot blowers, which reduce routine hand-lancing to the minimum.

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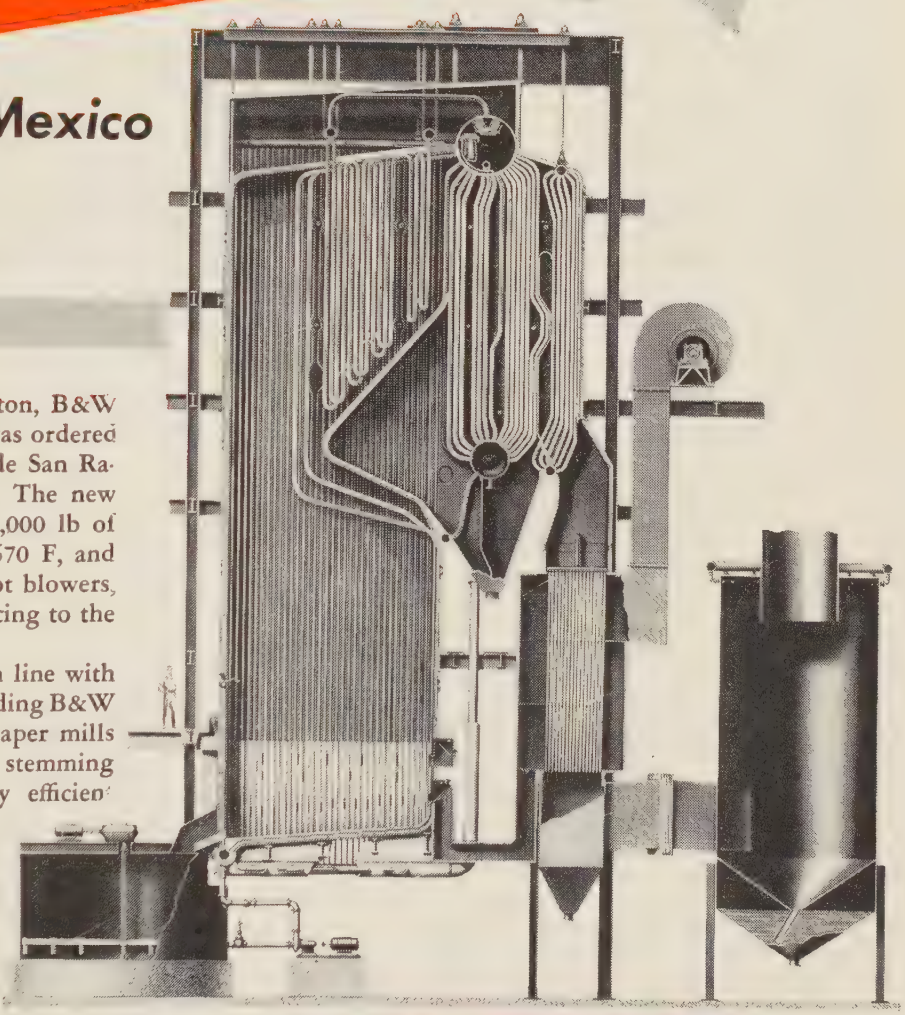

Typical B&W 2-Drum Recovery Unit equipped with B&W Cyclone Evaporator

BABCOCK & WILCOX
BOILER DIVISION

P-776

First, the industry (packers and distributors) is just beginning to realize that cabinets are as necessary as packages, trucks, and salesmen. The industry itself, whether it likes it or not, will eventually have to take the bull by the horns and work out satisfactory cabinet deals so that retailers can get cases easily and with long-term credit. The retailer has been apathetic to cabinets, although he realizes that he must carry frozen foods today. Of course, many stores do not have room for added cabinet space and this is a real problem with such existing outlets. But there is still enough space in the nation's stores for at least 3 to 400,000 additional cabinets.

While it is not claimed that all cabinets can or should be sold direct to the industry, there are many instances where cabinets can be placed at a price at least 50% less, where the local store equipment dealer is circumvented. This is now being done to an increasing degree, although many cabinets are also being sold through existing refrigeration distribution channels.

In a survey (QFF, August, 1951), in answer to the question—"What is holding back adequate cabinet sales?"—62.5% of distributors queried gave cabinet prices as the main reason, 16.5% gave retailer inertia, 12.5% said store equipment distributors did not show sufficient activity and interest in placing cabinets, and 8.5% gave lack of good financing deals.

A total of 45% of frozen food distributors who had cabinet deals reported they bought cabinets and either assumed financing for them, leased them or sold them outright for handling charges only. Another 43% said they worked with local store equipment distributors, allowing them to handle the deal and servicing, with the frozen food distributor's salesmen turning in the leads. Some 12% reported they loaned cabinets to retailers at no cost to the retailer. (Some of these plans were sponsored by packers such as Minute Maid, Snow Crop, etc.) A total of 45% of distributors answering said the minimum size of cabinet needed today was 20 cu. ft. or over. Many thought more backroom storage space was important.

In the entire field of commercial refrigeration there is probably no market which offers a greater potential for the sale of new equipment than does the frozen foods industry in the placement of cabinets in retail stores.

Most packers who reach national distribution work out some sort of cabinet deal so that store units are available to their distributors for quick placement in retail stores. Some distributors have found the handling of cabinets a profitable business; one New York wholesaler places an average of from 40 to 60 a month.

At first many distributors felt that if they placed a cabinet they lost control of it, which, in a sense is true. Others don't want to get involved with equipment and servicing. Yet, as the industry moves on with increasing momentum, it is being proved that it is still better to have more outlets to service—even though they are not all exclusive stops for the distributor who places the cabinets—than to watch this increased business go by default, or to somebody else.

The latest trend is toward the decentralization of cabinets: one holding concentrates, another fruits and vegetables and still another poultry, meats, and specialties, strategically placed in various departments. Other stores prefer to build up their frozen foods department by the addition of more cabinets in one place. A recent chain survey (QFF, November, 1951) showed that chains preferred to put cabinets next to produce departments giving the shopper her choice; second preference was next to meat cases, and third, near the check-out counter.

Cabinet development is toward the open reach-in type. The "coffin" type is rapidly becoming a thing of the past. Latest is an island type of table display. Still another development concerns an improved type of dry ice table for open display merchandising of concentrates and frozen foods. The tables are inexpensive and especially constructed to provide zero temperatures through the use of a minimum amount of dry ice. The unit is especially designed for high traffic stores and for week-end use.

PACKAGING

Few industries offer the packaging manufacturer the variety of applications and the growing volume of sales potential that the frozen foods industry can. In 1951, for instance, a total packaging market for 1160 million lb. of frozen foods was offered by this industry. This total breaks down as follows: 500 million lb. in retail packages for vegetables, 100 million lb. for fruits, another 150 million in institutional sizes up to 5 lb. for fruits and vegetables; 150 million lb. of poultry in retail and institutional sizes, 30 million lb. of meats in retail and institutional, 80 million lb. of specialties, mostly in retail sizes, 150 million lb. of seafoods in retail and institutional packages. In addition, there are 800 million 6 and 32-oz. concentrate cans and a sizable locker plant and home freezer packaging market.

Never before has there been such an array of frozen food packaging—almost every month brings a host of new frozen food items upon the market. Many of these products are packaged in multicolored vignettes and designs using wax paper, cellophane, various laminations, foil, etc. New types of board are constantly being supplied.

It is interesting to note, for instance, that the number of seafood packages, especially 1-lb. fillets and shrimp packages have almost doubled in one year. Drawing from a whole range of industries—vegetables, fruits, poultry, seafoods, meats, specialties, concentrates—there is an ever increasing variety of products coming into the market which must be attractively packaged. This offers not only a market but a challenge to the packaging industry.

Frozen foods are further away from standardization than ever before. There will never be a universal package for all frozen products because of the different sizes and shapes of the various products. Competition and diverse marketing trends, too, have added to the differentiation of sizes. Seven or eight years ago fruit packages were pretty well standardized at 16 oz.; vegetable containers at 10 or 12 oz. Now we find everything from 8 oz. up. The reason, of course, is sharpening competition and the offering of smaller packages with their attendant price advantage. This irregularity of size is further prompted by the sale of second grade merchandise in retail packages, which lines also tend to smaller sizes.

Because of the wide range of foods which freezing covers there will always be odd-sized packages, but

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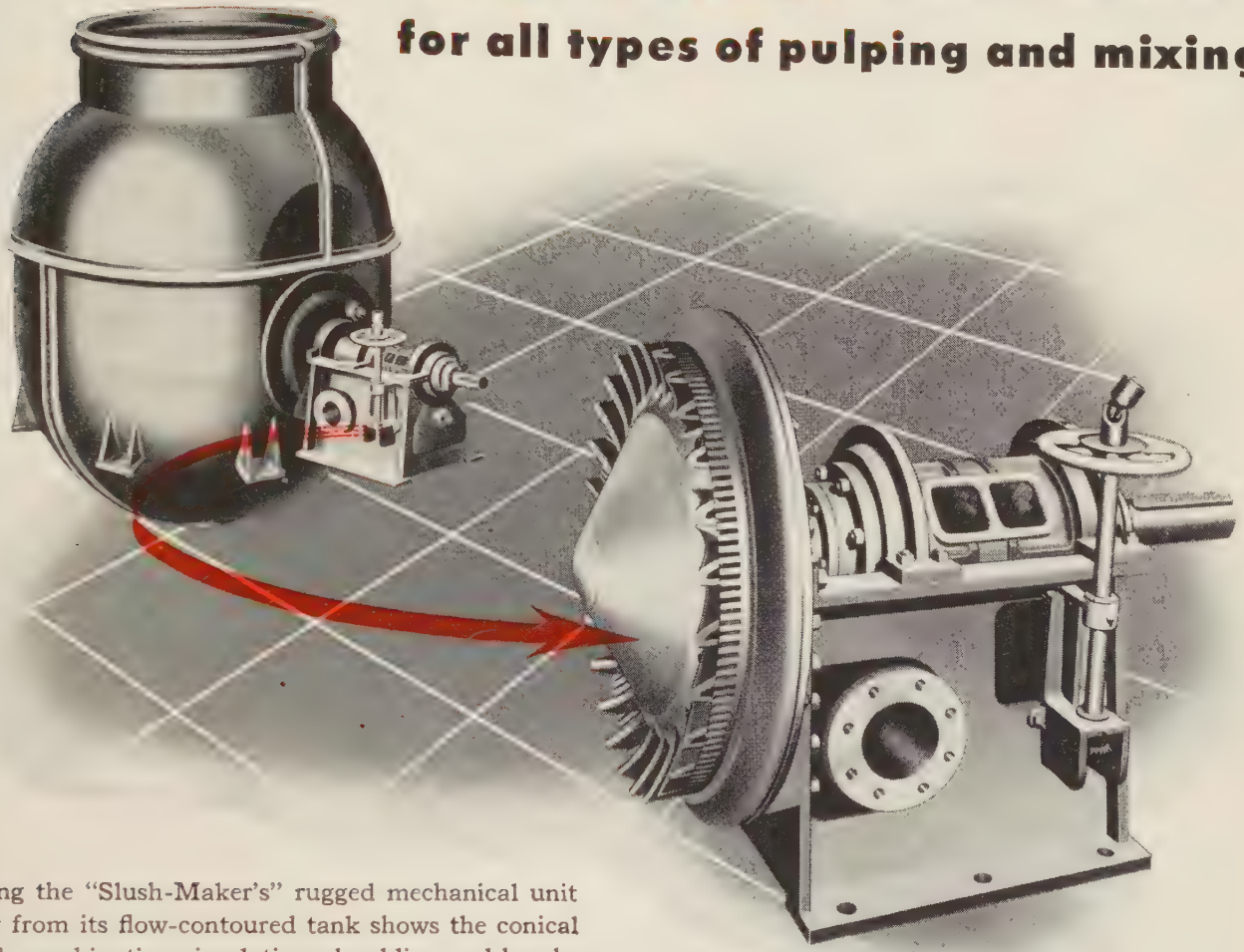

Pulling the "Slush-Maker's" rugged mechanical unit away from its flow-contoured tank shows the conical rotor's combination circulating, shredding and brushing blades, and bars on the stationary attritioning ring

Rapid initial disintegration is given by the rotor's shredding blades.

The positive-flow circulation, across the rotor's face, continually directs the partially broken material at right angles against the bed plate ring.

A hand wheel controlled setting of the rotor assembly can bring the bars on the back of the rotor blades into a brushing contact with the bars on the bed plate ring. This bar-to-bar brushing, when required, will quickly and completely clear all flakes and bundles—even high wet strength—without damage to the fibers.

The Morden "Slush-Maker" also thoroughly mixes and brushes in color, size and other materials in a matter of seconds.

The "Slush-Maker's" side mounted rotor quickly and efficiently slushes full charges of pulp, broke or waste paper, either batch or continuous.

Let us know your slushing requirements and we will gladly analyze how you can Morden-ize your pulping and mixing advantageously.

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Corbett Building, Portland, Ore.

eventually packages which can be standardized, such as vegetables and fruits, will have to become more uniform.

Below is a list of current package sizes (QFF, September, 1951):

Peas	74% of packers use 12 oz.
	26% of packers use 10 or 8 oz.
Lima beans	50% of packers use 12 oz.
	50% of packers use 10 oz.
Cut corn	75% of packers use 10 oz.
	15% of packers use 12 oz.
	10% of packers use 8 oz.
Winter vegetables	
String beans	Most packers use 10 oz.
Spinach	85% of packers use 14 oz.
	15% of packers use 12 oz.
Asparagus	55% of packers use 12 oz.
	45% of packers use 10 oz.
Mixed vegetables	70% of packers use 12 oz.
	30% of packers use 10 oz.
French fried potatoes	70% of packers use 9 oz.
	30% of packers use 10 oz.
Succotash	50% of packers use 10 oz.
	50% of packers use 12 oz.
Strawberries	65% of packers use 12 oz.
	30% of packers use 16 oz.
	5% of packers use 14 oz.
Raspberries	65% of packers use 12 oz.
	30% of packers use 16 oz.
	5% of packers use 14 oz.
Peaches	55% of packers use 12 oz.
	45% of packers use 16 oz.

Most 10-oz. vegetable containers are from 5 to $5^1/_4$ in. in length, 4 in. in width and $1^1/_2$ or $1^3/_4$ in. deep. Dimensions of other popular sizes are as follows: 12-oz. containers; 5 to $5^3/_8$ in. long by 4 in. wide and $1^1/_2$ to $1^3/_4$ in. deep. Most 16-oz. containers are 5 to $5^3/_8$ in. long by 4 in. wide and $1^3/_4$ in. deep. Pound fillet cartons average $8^1/_2$ to 9 in. long by 3 to $3^1/_4$ in. wide and $1^1/_2$ in. deep. Pound chicken part containers average $6^1/_2$ in. long by $3^3/_4$ in. wide and $1^3/_4$ in. deep. Shrimp packages in 10-oz. size measure $5^1/_4$ in. long by 4 in. wide and $1^1/_2$ in. deep.

There are now close to 1300 quick freezing plants, large and small, in the U. S. Most of them have at least two or three overwrapping machines (many have up to 10). In addition, they have filling equipment, scales, bag sealing machines, carton closers, completely automatic carton openers, fillers and sealers, heat sealing equipment, etc. The value of present packaging machinery alone has been estimated at between 5 to 8 billion dollars.

With a production of 7 to 8 billion pounds expected by 1957, the frozen foods industry will eventually offer the packaging trade a market for continuous supplies which, because of the great variety of items the line includes, may well outstrip any other market. The main requirement for frozen food packaging is that it should give protection for at least 12 to 18 months and be handled at high speed. The industry uses wrappers of high merchandising appeal and the tendency is toward automatic handling.

THE B-GRADE BRANDS

In 1951 something new was added to the frozen foods industry—the introduction of legitimate second quality brands, priced and presented (though not labeled), as such. These brands, of which QFF estimated there are now 10 lines (see QFF, July, 1951), include 10-oz. packages of peas, spinach, lima beans, broccoli, cauliflower, peas and carrots, cut corn, succotash, green beans, mixed vegetables, French fried potatoes, as well as an 11-oz. can of peaches and a 29¢ strawberry package. New low-priced items are being added such as a 19¢ rhubarb, melon balls, and of course, orange juice and lemonade are included.

For years the primary concept of frozen foods was based on the fact that only top grade merchandise should appear in the retail package. The debacle of 1946, when inferior merchandise gave the industry a severe body blow, served to reinforce this principle. But the industry has now advanced to the point where there undoubtedly is a sizable market for B-grade merchandise which formerly went into the institutional package.

As in the canned goods industry, there is room for grades which represent good, edible foods but not necessarily the top. Sales of these "economy" brands have been large and are growing. The base of distribution has been broadened. Many distributors have taken on second quality lines in addition to first quality lines and report increasing sales on both. The B brands are "naturals" for super-markets and cut price stores.

How are B brands affecting the industry leaders such as Birds Eye, Snow Crop, Libby, etc? A QFF survey reported that industry opinion showed that there might be a slight and temporary drop in the sale of A grade at first but that eventually the growth of second quality lines would aid the sale of first quality brands because it would (1) increase consumption generally, (2) make people more conscious of quality and thereby bring out A brands in bold relief to the general run of industry merchandise.

The main problem presented by second quality or "economy" brands today is not one of sales but of procurement. Since the industry started, both growers and packers have been educated to furnish the top quality of the pack. Suddenly, there is an increased demand for second quality.

Only about 15% of most packs now runs to second grade, at least as defined by present standards. Therefore, some A or top B merchandise has now been going into the 19¢ brands, but how long this situation will continue remains doubtful. QFF believes that new sources will have to be developed to supply B grade demand if it grows. Meanwhile, it is possible that grade A packers may have to revise the exacting standards they have used on frozen foods—not necessarily downward but with more emphasis on flavor and appearance.

At any rate, the impact of B grade will undoubedly result in benefit to the industry—if such merchandise is kept at honest B quality level. The main thing is that the public must be made to understand that it is getting just what it pays for. Continued advances in B or "economy" brand sales will have a decided effect on packing and may, in the next few years, revolutionize standard practices.

It will affect brokers and distributors too. It should spur the installation of new cabinets in retail outlets and enlarge space devoted to frozen foods in existing stores. It should also augment dollar volume. By making two grades of frozen foods available to the public, it should once and for all, take frozen products out of the luxury class.

Lasting Crowns—More use per Dollar

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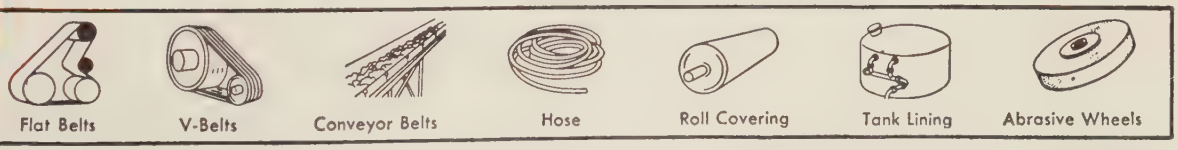

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HOME FREEZERS

The rapid sale of home and farm freezers is a development to which the frozen foods industry has not given a sufficient amount of attention. For, every time a home freezer is placed, more zero storage space has been created in somebody's home—a receptacle for storing case lots of frozen foods.

Home freezer owners are using more and more case lots all the time. And home unit sales have been growing at an amazing rate: as of January 1, there were about $3^1/_2$ million home and farm freezers in the country; monthly sales are at the rate of about 65 to 70,000 units. Sales of these units have grown over 100% in the past 2 years and there are now over 52 million cu. ft. of zero storage space in American homes—enough for storing over 2 billion lb. of frozen foods! In addition, there are over 33 million refrigerators in use, most of the newer ones having frozen food compartments.

Home freezers have been handled and sold by locker plants and some frozen food distributors have also found the deal a profitable one. Besides, there are today 30 distributors selling direct to homes, that is, serving home freezer owners.

In order to affect a closer connection between the frozen food industry and the growing army of home freezer owners, QFF in 1949 inaugurated "Stock Your Home Freezer" month in October. Frozen food distributors and retailers all over the country jointed forces with home freezer manufacturers in support of this promotion.

During that period, and the year following, over 100 distributors made case lots and quantity assortments available to retailers at special discounts to encourage the sale of home cabinets as well as to set machinery in motion for the smooth flow of bulk lots from retail display cases to the homes of freezer owners. QFF supplied point-of-sale display material for retailers in the form of posters reading "This Is Stock Your Home Freezer Month—Fill Your Freezer Here and Save Money." Freezer makers tied in by calling upon their distributors and dealers to cooperate with local frozen food distributors in joint advertising and promotional efforts to sell more home freezers.

The importance of home units cannot be overly emphasized. Most people who buy a new freezer are ignorant of how to use it. With the exception of farmers, and these are in the minority, the majority of freezer owners cannot possibly put their unit to economical use by home freezing. But, by taking advantage of sales and by being able to buy case lots of concentrates, leading vegetables and fruits, poultry, and other items, they can, over a period of time, pay for the cost of the cabinet.

DECENTRALIZATION OF THE INDUSTRY

One of the most important production trends has been the decentralization of frozen food packing, for which QFF has campaigned for years. (QFF, September, 1951). The time has past when any one section of the country, no matter how proficient it may be in the packing of certain items, can continue a monopoly on production—and this is especially true in fruits and vegetables.

Decentralization is also important because it makes more markets available to the buyer and, tending to eliminate peaks and valleys, keeps frozen food prices at steadier levels. Likewise, it is a safeguard against crop losses in any one area and furthermore, tends to equalize freight rates.

The trend is now well under way; for instance, strawberries for years came almost exclusively from the northwest. Today, they come from the south, the northeast, the middlewest, and California. Pea packing is also widely spread, as is the freezing of winter vegetables, lima beans, and other items. Poultry, formerly restricted to states like Illinois and Nebraska, is now being frozen in Georgia, along the southeastern shore, in the northwest, California, and other areas. Concentrating of juices is taking place in California as well as Florida; seafood freezing is no longer restricted to New England.

Freezing today is going on the year round. There is no longer a single month in which frozen foods are not packed; strawberries start in Florida in January and work north; winter vegetables are being packed in the fall and spring in many states; when the concentration of juices stops in Florida in June, it starts in California. Poultry, meats, and seafoods are frozen the year round as are specialty items. Frozen foods today is no longer a seasonal industry.

MILITARY BUYING

The Quartermaster Corps' procurement of frozen foods is on the increase. While the schedule for 1951 had called for an over-all total of 66.7 million lb. of frozen fruits, vegetables and concentrates (as compared with 38 million lb. in 1950)—by October, 1951, the QMC was way ahead of its estimate. For the first 10 months of 1951, the Army bought 67 million lb. of vegetables alone, as compared to $29^1/_2$ million lb. for the whole previous year. It bought over 19 million lb. of fruits versus 8.5 million lb. for the whole of 1950 and 581,807 cases of orange juice concentrates as against 231,935 for entire 1950. Plans for 1952 are expected to show a considerable increase over 1951.

Of the frozen products procured in 1951, most were for export, a large portion of which is used in Army messes. Our foreign population is growing (troops in Europe, Korea, Japan, and their families).

For the first time in 1951, certain divisions of the QMC decided to put frozen foods on their planned menus (QFF, October, 1951), which means that they are becoming a regular part of the established program, while up to now they have been used more on a "fill in" basis. A detailed survey was made by an Army branch in Germany recently of frozen, canned, and fresh foods from a cost standpoint. Frozen foods were found cheaper! While some other foods looked like better buys on paper because of the availability of kitchen help in the Army, the latest thinking recognizes the fact that this same labor can be used to better advantage than shelling peas and washing spinach.

According to the Quartermaster Market Center System in Chicago, the present aim of putting $3^1/_2$ million men under arms by 1952 means more mouths to feed. They have stated that "a considerable increase of frozen fruits and vegetables will be utilized by the Armed Forces." Orange juice concentrate alone reached 11 million converted lb. in 1951.

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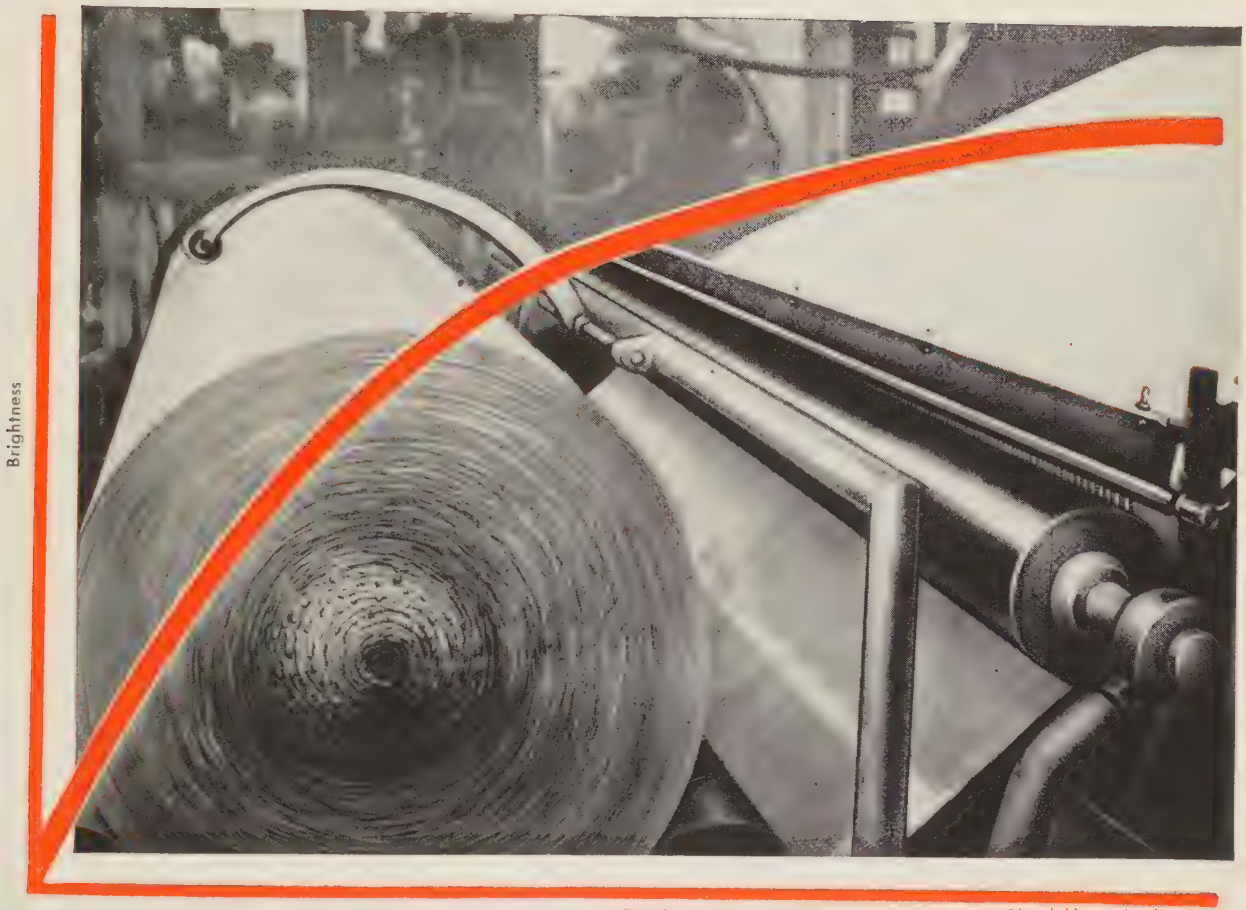

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The vegetables most frequently appearing on the QMC menu are: spinach, broccoli, cauliflower, asparagus spears, peas, and sprouts. The frequency of use increased from one to four times a month in 1950 to an average of six times a month in 1951. The issue factor on frozen vegetables is 10 lb. per 100 men for one meal. The issue factor of frozen concentrated orange juice is 4 qt. per 100 men and it is issued from six to eight times monthly during the winter season and 10 to 12 times a month during the summer months.

THE PUBLIC'S TASTES

All frozen foods are by no means perfected; it would be not only a discredit to the industry but plain foolishness to assume so. Strawberries, though ever the most popular of fruits, still present the problem of how to maintain a firmer berry after defrosting. The same is true of peaches, the future of which, if the product is improved, should not be discounted.

Green beans can be improved. In France, for instance, there is a variety superior to anything we have in this country—a thinner, rounder, and tastier bean. Brussels sprouts in Holland are smaller, more flavorful, and greener than here. Frozen cut corn could be sweeter. Varieties change also, and often for the better.

For years QFF campaigned for a smaller pea. This was finally produced in the form of the Wyola variety from California and its acceptance was immediate. The industry most constantly experiment not only to improve existing varieties and products, but to develop new and better ones. For instance, the addition of sugar syrup to rhubarb some time ago greatly increased its market.

Public tastes change, too, and our constantly shifting population has broadened the popularity of what were once considered purely sectional foods. For instance, okra is a vegetable which is growing in sales nationally. With okra, originally thought to be popular to southern tastes exclusively, it is interesting to note that 5 million lb. were packed in 1951.

The history of the frozen foods industry shows that the "under-privileged" items of today often turn out to be leaders tomorrow. A product that has proved a failure in the past may not necessarily be a poor bet. The timing may have been wrong. Promotion, quality, and price may have been unsatisfactory. If the product had been sponsored in the 1945–46 era of overproduction, it never really had a fair chance. There are a number of such items that bear out the adage that there is really no such thing as a "dead duck" in the frozen foods industry.

Frozen waffles are a case in point. These had been produced since 1943 with little success. But in 1951 one large company started advertising on the radio and waffles thereafter began to sell in volume. Chopped spinach and chopped broccoli took some time to catch on but today they are popular items. Whip toppings, thought to be doomed when the war ended, are stronger than ever.

Frozen horse meat has reached a phenomenal sales volume. Frozen lemon juice concentrate is an item which, though not large in volume, has held a steady price. The public's appetite for fried foods is growing all the time and the frozen foods industry is benefiting and should cater even more to that taste. Breaded fantail shrimp sales are expanding; breaded fish fillets are now coming out. French fried potatoes, and to a lesser degree, French fried onions, have similarly proved popular.

Sometimes, what a poor processor with an undeveloped selling organization was not able to put over, may become a success when in the hands of a good packer with a live sales staff. In the constant drive for volume, packers and distributors are frequently too impatient. If a new product does not move immediately, the inclination is to look upon it as a "dog." The development of marketing research is a necessity in this industry and while most large organizations such as Birds Eye, Libby, and Snow Crop do have such departments, many smaller packers would find an investment in both product and marketing research considerably worth while.

TRANSPORTATION

The sale of transportation equipment to the frozen foods industry is growing at a rapid rate. Trucks and truck lines have benefited particularly. Seven years ago over 80% of frozen food shipments were made by railroad; today the situation is reversed and over 65% of the industry's tonnage is carried by trucks. There are obvious reasons for this reversal: (1) trucks generally keep frozen foods at lower temperatures than railroad carriers (zero or below against 15°), (2) they offer direct-to-door delivery, (3) they are more maneuverable, and (4) are constantly enlarging their fleets and coverage.

Some railroad lines, however, alarmed by the serious inroads which truck lines have made in their tonnage have gone into mechanically refrigerated cars. The Fruit Growers Express Co. and associated lines already have over 100 such cars in operation (they use Thermo-King and Frigidaire units). This, of course, is a big improvement over the present ice and brine method—a system never intended for frozen foods. Other lines are building more, larger, heavily insulated, overhead-bunker cars with a minimum of 6 in. of insulation.

Recently, the superiority of mechanical refrigeration over dry ice and salted water ice in rail transportation was indicated in a report of the U. S. Dept. of Agriculture. Tests were run on 11 refrigerated cars (QFF, December, 1951, p. 96) and the report stated that the lowest temperatures were provided by two mechanically refrigerated cars. Concentrate temperatures were maintained with 5° of the loading averages. The poorest performance was that of a fan car with ice and salt, the commodity temperatures rising from an average of −1° at origin to 10.5° at destination, with maximum temperatures up to 18.5° being registered.

Another trend that has favored trucks is the fact that distributors have found it necessary to work on low inventories which has brought about a demand for truck loads at a 20,000-lb. minimum as compared to carloads at a 40,000-lb. minimum. Shippers use both common and contract carriers. The average rate of transporting frozen foods by rail today is about 2¢ a lb., by truck about $1^1/_4$¢ a lb.

Trucks are being more and more used and purchased by packers and distributors. Trucks used by the industry vary between $1^1/_2$ and 10-ton capacities, al-

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though the trend is constantly in the direction of larger trucks. A recent survey by QFF revealed that over 60% of distributors now own trucks, averaging five to seven each, although many own much larger fleets. Frozen food packers often operate fleets of from 10 upwards.

WAREHOUSING

Zero degree storage space in U. S. cold storage warehouses has increased over 30 million cu. ft. since 1947. Warehouses are finding that there is more money in freezer than in ordinary cold storage space and whereas 10 years ago the ratio was 3 to 1 in favor of cold storage space, today it is reversed.

More than 88% of new space was accounted for by the sharp growth in freezer capacity. The biggest gains in new freezer capacity were made in the states of Washington, Oregon, and California. However, big gains have also been shown in other areas. Least growth was indicated in the middle Atlantic states.

Will there be a shortage of storage space? In some areas the answer is probably yes. In other areas there is space to be had. But percentage-wise, the frozen food industry has grown faster than new freezer space in public warehouses, and indeed, the industry would not have been able to expand as it has if packers and distributors had not built their own storage space.

This trend is continuing unabated. During the past year many frozen food packers have greatly increased their own storage capacity and today about 60% of the nation's larger distributors have ample warehouse space on their premises.

It seems obvious that during the next two years more public freezer space will have to be installed, especially in main arterial centers. At the moment, freezer space is tight in many parts of the country. While USDA freezer storage holdings show only 70 to 80% occupancy, this is often misleading since space is 90% occupied in important arterial centers but often only 50% filled in small, unimportant centers or points where warehouse space has been misplaced. This tends to bring down the over-all average. Neverthless, space is becoming very scarce in strategically located cities. In case of war, the situation would be critical.

THE CONCENTRATES

By the middle of 1950, frozen orange juice concentrate had become firmly established in the minds of retailers as a staple item—like coffee, tomato juice, soap, or cheese. But along with the privileges of being a staple item also went the penalties of intense competition and price cutting. As a result, while volume grew phenomenally, profits narrowed. Of the close to 200 million dollars spent at the retail level for orange juice concentrate in 1951, 80% was for the four largest concentrators, Minute Maid, Snow Corp, Birds Eye and Pasco. Toward the latter half of 1951 Sunkist entered the field in force and, through national promotion and price slashes captured, more or less permanently, a portion of the market. Libby is the sixth national name.

Production of orange juice concentrate has climbed steadily: 1947–48—$2^1/_2$ million gal.; 1948–49—12 million gal., 1949–50—25 million gal.; 1950–51—36–37 million gal. (including California).

There are now approximately 50 concentrators in the U. S., of which about 85% are in Florida. This includes processors (nationally) of orange juice, grapefruit juice, lemonade, lemon juice, limeade, blend, tangerine juice, grapejuice, tomato and apple juices and coffee concentrates. Besides this there is also cranberry juice and malted milk (Horlicks) in frozen, concentrated form. Milk concentrate in frozen form has been practically perfected and tested and found to have better holding qualities than the unfrozen concentrated, although the latter seems more popular at the moment.

The day of unbridled competition among concentrators in bidding for Florida oranges seems to be past. As of the beginning of 1952, Florida faces the task of marketing 112.7 million boxes of citrus products, of which $72^1/_2$ million boxes are oranges. The price of raw materials should be sufficiently low to yield a retail seller from 17 to 19¢ for unknown labels and from 19 to 21¢ for advertised brands. There will undoubtedly be price concessions throughout the year; few industries can boast of so erratic a price history as the concentrate business.

No stabilization is yet in sight, despite a more level price at the grower's end, which situation has been improved by the growing domination of cooperatives in the picture. The recent Snow Crop-Florida Citrus Exchange deal frees Snow Crop from plant operation and gives the Exchange an assured "home" for its fruit. This involves at least one-third of Florida production. Sunkist, another cooperative, already controls California production.

QFF's monthly "Best Seller" reports, while showing orange juice in undisputed first place in concentrates, showed grape juice as a second. More recently, lemonade has disputed second place with grape juice concentrate.

Tangerine juice has been growing in popularity, although limited in supply. Blend, while not spectacular, has shown progress and may some day come close to second place. Grapefuit juice still lags but should do better in time. Lemonade did very well in 1951, although it is primarily a May to October seller; Sunkist will advertise it for winter sales.

Limeade is another summer item with possibilities, so is orangeade. Both coffee and tomato juice concentrates have remained steady but progress has been somewhat disappointing. Of the two, coffee, if improved, shows the greater potentiality.

Battle lines within the industry are drawn not only between Florida concentrators but on the larger issue of Florida versus California. Determined to make its mark, California's challenger, Sunkist, splashed into the market in 1951 with a barrage of advertising and price inducements. Will the Sunkist name, backed by many years of promotion, sway the consumer? Perhaps, though frozen food history shows that important brand names in other fields do not necessarily have the same magic appeal when applied to frozen foods. In the final analysis (QFF, November, 1951), the battle of Florida versus California juice will not be decided by brand names, advertising, or even price, but by taste and flavor. Will the consumer like the tarter California juice enough to buy it in quantity? So far the buyer of concentrates has been educated to the taste of the Florida orange. Taste will tell.

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Meanwhile, 1952 estimates are optimistic. Encouraged by a growing rate of sale ($2^1/_2$ to 3 million gal. monthly, December, 1951), and unperturbed by any carryover, Florida concentrators are talking of a 36 to 42 million gal. pack. At present, concentrates utilize about 40% of Florida oranges; in an other 5 years estimates indicate 75% of the crop will go into concentrate cans.

How far can orange juice and its fellow concentrates go? Up to now per capita consumption is only about three cans per person, per year. If compared with the soft drink business, frozen concentrates are still in knee britches. In 1949, per capita consumption of all bottled soft drinks was 162. This represents well over a billion cases (24 bottles per case), and a total volume of 837 million dollars! Compare this with the present concentrate volume of 180 to 200 million dollars a year. A 6-oz. can reconstitutes to a pint and a half, representing more contents than the average 6-oz. beverage bottle. If drinks like Coca-Cola should ever be forced to 10¢, orange juice would receive a great impetus. For export, too, all of Europe is wide open to the concentrates.

A considerable market for the institutional concentrate pack now awaits exploitation in the country's restaurants and fountains through the installation of counter dispensers and vending machines in public places. It has been estimated that between 100 to 150,000 dispensers will go into use during the next 5 year (QFF, June, 1951).

To date, Minute Maid and Snow Crop have been the most active in the placement of dispensers. Snow Crop has put out 15,000 mechanically refrigerated counter units of its own design on a loan basis. Minute Maid has sold outright 1000 ice-refrigerated and 200 mechanically refrigerated machines plus a number of coin-operated vending machines. Pasco, it is understood, is also entering this business. There are now some 16 dispensers on the market with more expected to enter the business.

The average sale per dispenser runs about 2 cases a week. In high traffic spots, however, sales are often much more. Most deals are made on the basis of an agreed minimum purchase by the restaurant or fountain, with the dispenser being either loaned or sold outright. There are of course abuses which require constant policing, such as substitution of other drinks, watering, and carlessness of sanitation. However, most restaurants are now realizing that quality must be maintained for results.

Mills Industries of Chicago has just put out a new coin vending machine for both orange juice and lemonade concentrate in the same unit with a red button for orange juice and a yellow button for lemonade. The machine makes change, has ultraviolet radiation for cups, water purification, and straining, and can hold the concentrate at zero. The drink is mixed at the moment of sale, eliminating oxidation. The unit holds 600 5-oz. cups, sells for $1100. A choice spot such as a railroad or subway station yields up to 600 drinks a day.

The placement of a minimum of 100,000 dispensers would dispose of close to 70% of the current pack.

FROZEN POULTRY

Few categories of frozen foods have matched the growth of quick frozen, eviscerated poultry, which, according to latest 1951 estimates, were sold nationally to the tune of about 300 million lb. Dollar-wise and poundage-wise, frozen poultry increased 80% between 1947 and 1951.

Today there are some 60 packers of frozen, eviscerated chickens, chicken parts, turkeys, ducks, giblets, livers, etc. (QFF 1952 Processors Directory). Nevertheless, the progress of frozen poultry is not an altogether easy one; there are some impediments in the way. Fresh cut-up iced poultry provides considerable competition and in some cases, too high mark-ups on the part of distributors and retailers has slowed down the advance of the frozen products.

Some producers advocate that distributors, instead of applying the customary percentage mark-up to poultry, use a pound unit basis mark-up to avoid a disproportionate mark-up between the fresh and frozen item, which differential is frequently from 20 to 35% at retail. Where distributor and retailer have worked on short margins there has been a very substantial volume generated and over-all gross profit return has more than offset these shorter operating margins.

The commercial broiler industry is one of the fastest growing America. During the past 2 years the Del-Mar, Va., territory increased its output over 90%. Georgia has increased its production almost 700% since 1943. Such leading frozen poultry packers as Birds Eye, Swanson, Jewell, Armour, Swift, Ocoma, and many smaller ones have stepped up advertising and promotion. Frozen poultry is processed today in practically every part of the U. S. According to a consumer survey in Milwaukee, the percentage of families that purchased frozen eviscerated poultry regularly or occasionally increased 117% between 1948 and 1950 (QFF, March, 1951).

Because frozen poultry can be stored and shipped great distances after being quick frozen, the grower and processor can operate under climatic conditions favorable to broiler production. Being able to operate at a distance from consuming areas, the grower and eviscerator can utilize low-cost land, low labor rates, plentiful labor, and cheap building costs. On the other hand, the fresh, drawn, ice-packed poultry is denied these advantages.

The processor of frozen cut-up fryers and poultry can assure his customers of a steady supply of chickens the year round. By building up a backlog during low live-price periods and slowing production when prices are high, he can stabilize both buying and selling prices and assure his customers of satisfying their needs at a fairly stable price range. The management of prices and back-logging of supplies is denied the processor of fresh poultry.

Before World War II less than 15% of the total chicken meat production consisted of commercial broilers. Today over 35% of total production is commerically raised under controlled conditions. The quality of quick frozen eviscerated poultry today is far better than ever before. Unlike the fresh product, it will not spoil—a fact which the industry sometimes overlooks by pricing the frozen product too high.

Present and prospective high meat prices have done much and will continue to exert an important influence on the growing sale of frozen poultry, as has an in-

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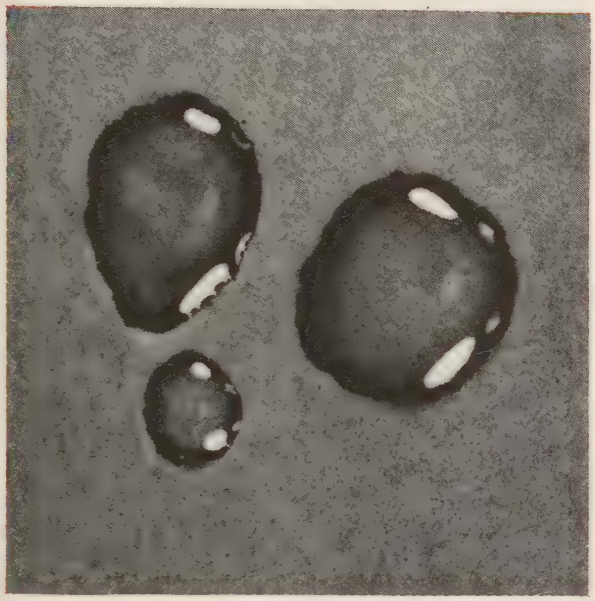

This unretouched photograph shows a 1% solution of Kelsize twenty minutes after being puddled on blotter. Note how solution remains on surface of blotter. This test illustrates that Kelsize is an excellent material for controlling penetration and strike through of aqueous solutions, thus increasing the efficiency of adhesive or surface sizing solutions by retaining them at the area of application.

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creased availability of attractively packaged varieties of types, sizes, and cuts of frozen poultry. An increasingly tight labor market is forcing economies in the meat departments of many stores, a factor which is helping the sale of the frozen product out of the zero cabinet.

FROZEN MEATS

Despite severely hampering OPS price regulations, frozen meats have shown remarkable progress and sales are increasing weekly. In the year before the war about 18 million lb. of quick frozen meats were sold; Birds Eye, Honor Brand, and others had fairly complete lines. With the war, frozen meats went into an eclipse, only to emerge with a volume of about 20 million lb. in 1948. With the advent of the OPS, the sale of frozen meats took another, but only temporary, nosedive and toward the end of 1951 they began to come back in volume with an estimated 60 to 75 million lb. expected to be sold in 1952.

There are today approximately 40 meat packers, large and small (QFF 1952 Processors Directory), turning out a variety of quick frozen meat cuts. The most popular, in the order of their importance, seem to be: chopped beef, minute steaks (variously known as cube steaks, steakettes, sandwich steaks, steakees, etc.), veal cutlets, pork cuts. There has been an attempt to market offal cuts with indifferent success. Eventually, however, the full-blown meat line including steaks, chops, roasts, etc., is expected to fill out the line but so far 90% of the business is restricted to the popular cuts mentioned.

Frozen food distributors have been prone to take on meats which seem to find a ready place in the store cabinets. Distributors operate on a mark-up of anywhere from 15 to 24%. Chains sell frozen meat at an average mark-up of 20.8% (QFF, November, 1951). In a recent survey of a super-market chain in New England, frozen meats were third in volume, being topped only by vegetables and concentrates.

Leaders are now tackling frozen meat sales with renewed vigor. Armour for the first time will have a budget in 1952 to plug frozen meats to the consumer. Hygrade Food Products has just brought out a new line. Swift & Co., oldest pioneer in frozen meats (1930), is treading more cautiously, but is in the picture. Rath & Co., Wilson & Co., and other packers have lines ready to launch at the proper moment. Meanwhile, hardly a good-sized city is without at least one local supplier of frozen meat products. Packaging is attractive; smaller packers use cellophane for vision, larger ones tend toward closed cartons, depending upon the name value for identification.

QFF believes that the development of frozen meats depends upon the large meat packer. At present, frozen meats are largely off-hour sellers in markets which remain open after larger stores with fresh meats to sell are closed. The frozen product does not have the convenience factor of vegetables, concentrates, and some other frozen foods—in fact, frozen meats must first be thawed. However, in quality, frozen meats are equal to fresh; in fact they have a tenderizing tendency. In busy markets customers can serve themselves quickly and can buy by brand. Chops and steaks are better trimmed also.

The institutional trade, the largest user of frozen meats, is buying more every year on the basis that with pre-packaged and frozen meats, restaurants get predefined costs with spoilage eliminated. Much of the opposition which originally came from stewards, whose standard practice of purchasing was circumvented by the sale of frozen cuts on which the margin was closely estimated, has largely been overcome.

All in all, the production, distribution and sale of frozen meats are of greatest advantage to the meat packer. But its value is only in relation to its universality. The greater the volume of a packer's output in frozen form, the greater the economies affected.

By pre-packaging and quick freezing meats at the packing plant, packers have controlled distribution, they can brand each cut, and costs can be reduced through greater offal recovery at the plant as well as weight reduction in freight shipments. The present costly branch house structure of large packers can be considerably simplified. Also, a variety of choice meats can be stocked at any warehouse point.

Squarely in the way of large-scale development of frozen meats stand the butcher unions and some retailers. But their opposition is not as strong as it was, and if the cutting-freezing-packaging of meat cuts in centralized plants proves the final answer (a matter of 20 to 20 years), unions will have to give way. Meanwhile, pre-packaged meats have long been sold in supermarkets; they may be the bridge between the fresh meat counter and quick frozen meats.

Several factors are working in favor of frozen meats. Store labor today is higher than ever; there is shrinkage, labor in cutting the meat and time spent in serving the customer. Fresh meat is the only important food today still sold à la merchandising of the cracker-barrel era. The "blood stained butcher block" is getting to be a thing of the past. As frozen foods become more popular, as more and more food buying is done at the frozen food cabinet, it is quite likely that the freezing industry will carry meats along with it in its up-swing.

Pre-cooked meat dishes, which suffered from too-early introduction, poor quality, and careless packing, are coming back again too in much improved form. If prepared right and offered at realistic prices, pre-cooked meat items should eventually become a very important category of the line.

FROZEN SEAFOODS

During the past two years frozen seafoods (fillets, shellfish, etc.) made more progress than any other frozen food line except concentrates. In 1950 about 170 million lb. of frozen seafoods were packed; by 1951 this had jumped to almost 300 million lb. (QFF 1952 Processors Directory). It is estimated that by the end of 1952 the total should reach around 400 million lb.

What accounted for the sudden spurt which increased volume of quick frozen seafoods 200% since 1945? There are two main factors: (1) the high prices of meats, and (2) the fact that seafood packers are realizing that fish sells better when frozen, attractively packaged and with the advantages of no odor, no waste, no bones. The base of distribution is also broadened; no longer are seafoods limited to fresh outlets but can reach the consumer through the frozen food cabinet as well as institutionally.

Important facts about pH for **PAPER MILL OPERATORS**

WHETHER YOUR mill operations are large or small, one of the most important advancements you can make is the installation of BECKMAN pH CONTROL. Through accurate pH control you can make *many* vital savings . . . savings that will quickly pay for the installation and will *continue* paying big dividends throughout the years by stepping up plant efficiency, reducing waste and cutting costly maintenance. For example:

- Beckman pH Control is used to insure more uniform pre-conditioning of plant water and substantial savings in chemicals.
- Many kraft mills insure cleaner pulp by checking the efficiency of the washers with Beckman pH Control.
- By Beckman-controlling the pH of the furnish or white water, proper freeness is assured at lowest chemical cost and minimum corrosion of costly wire.
- In making sized sheet and paper board, the set of the size is also critically dependent upon accurate pH control.
- Beckman pH Control is also used to insure better printing qualities of the finished paper—its ability to take ink, its whiteness, its strength and its color stability.

. . . and many other important savings in modern pulp and paper mill operations.

Write for full details.

TO MAKE CERTAIN you get the latest, most convenient and most accurate pH equipment, *be sure to specify* "BECKMAN" . . .

* Beckman pH equipment is completely electrometric, eliminating the mess and inaccuracies of colorimetric methods. Simply press a button and the exact pH of any process is instantly shown on a large easily-read dial. *It is the simplest of all pH methods!*

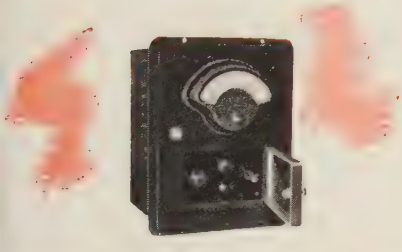
* With Beckman equipment no time-wasting or troublesome sampling devices are needed. Beckman pH electrodes may be installed directly in vats, tanks, channels or flow lines—and exact pH values read instantly—and *continuously*, if desired—on the process fluids themselves.

* The accuracy of Beckman pH readings is completely unaffected by human errors in color judgment, by turbidity, oxidizing or reducing agents, by suspended materials, colored process solutions or other variables that affect outmoded colorimetric methods. *Beckman pH readings are universally accurate and dependable!*

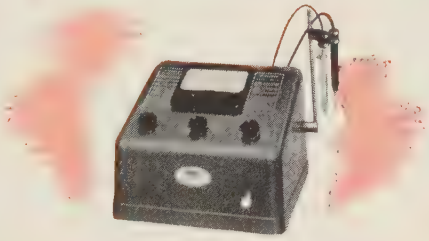
* Unique rugged-type Beckman Electrodes, especially designed for direct immersion in abrasive or suspension-laden fluids, reduce maintenance to an absolute minimum. *Beckman is the most trouble-free of all pH equipment!*

The above are only a few of many Beckman advantages. Write for the complete story.

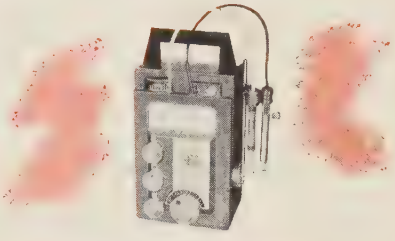
There's a Beckman pH Instrument to meet your needs!



COMPLETELY AUTOMATIC! The Beckman Model R instrument operates directly from standard 110 v. A.C. lines to provide completely automatic pH indication. Also provides for completely automatic pH recording and automatic process control. Can be installed to give accurate pH readings from various stations in plant through one instrument. *This is the pH unit being installed by today's most modern plants, large and small.*



PORTABLE A.C. OPERATION! The Beckman Model H instrument can be quickly moved from one part of the plant to another and plugs directly into standard 110 v A.C. current. Compact, convenient and extremely simple to operate, the Model H gives *instant* pH readings on an easily-read dial. Widely used both for manual pH control of small plants and as an auxiliary instrument on completely automatic pH installations.



COMPLETELY SELF-CONTAINED! The Beckman Model N is the ideal instrument where *complete* portability is desired. Operating from its own self-contained, long-life power supply, the Model N can be used *anywhere*—in plant, field or laboratory—without dependence on A. C. power circuits. Features maximum compactness, simplicity and operating convenience, coupled with extreme ruggedness.

BRING YOUR pH PROBLEM TO US. Our trained engineers will gladly study your problem and recommend the equipment best suited to your particular requirements. No obligation, of course.

See your nearest Beckman dealer for further details on Beckman pH Equipment. Or write direct for Data File 6-146.

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Beckman Instruments include: pH Meters and Electrodes—Spectrophotometers—Radioactivity Meters—Special Instruments

Frozen shrimp, in fantail breaded, peeled, and deveined, headless, and cocktail varieties has contributed to the total. The removal of frozen fish from price control also stimulated production.

Today, almost every type of frozen fishery product can be found in the consumer package, in addition to the institutional container, in sizes ranging from 4 to 16 oz. Shellfish and specialty products are usually packaged in less than 1-lb. sizes while fillets on the whole are packed in 16-oz. cartons. Frozen raw shrimp are packed in 12 and 16-oz. cartons while cooked shrimp are put up in 4, 5, and 6-oz. tins.

Oysters, clams, and scallops are packed in 10 and 12-oz. packages while breaded shrimp are put up in 10 and 12-oz. containers. There has been a marked improvement in packaging. In 1951 over 70 brands of quick frozen fish and shellfish were displayed at the National Fisheries Institute Convention in many new, multicolored wrappers of cellophane, wax, and foil.

The record shows that fish companies which have concentrated on merchandising frozen packaged products have increased sales, while per capita consumption of all fish products, largely fresh, remained stationary in 1950 and 1951 (still at about 11 lb. per person as compared to 132 lb. per capita for meat).

While many fish wholesalers are now becoming interested in getting into the frozen foods business to a greater degree so that they can do a bigger job of distributing frozen packaged fish, the sea food packers are also becoming interested in the frozen food wholesaler as a direct means of distribution.

Seafoods represent a big, sprawling industry which has suffered from lack of cohesion and leadership in the past. This now seems to be remedied by the activities of the National Fisheries Institute with headquarters at Washington, D. C. Large individual firms in the frozen seafood industry are few, the principal ones being General Seafoods owned by General Foods, Atlantic Coast Fisheries, Booth Fisheries, O'Donnell-Usen, Fishery Products, Gorton-Pew, British Columbia Packers, and Fisherman's Federation.

There are, however, hundreds of smaller companies now freezing. Since 1948, breaded shrimp and other frozen shrimp products have met with increasing success; the ready-to-fry products are especially popular in the south and midwest. Of late, studies have been made on the development of breaded fillets and these might prove important in the immediate future.

FROZEN SPECIALTIES

Much as been said about frozen food specialties. This category has had its ups and downs; it suffered in 1946 from careless production perhaps more than any other frozen item. Yet specialties have come back and in 1951 over 80 million pounds were produced.

There are some 250 frozen specialty packers. While there are few large companies in the field there are many small operations. The distribution of specialties, with a few exceptions, is generally restricted to a given area because they have not yet attained sufficient volume to permit much carload lot transportation. The necessity of relying on LCL shipments has plagued the specialty end of the frozen foods business for years; this can only be remedied as the various items that make up the specialty field attain greater volume.

During the past two years specialties have made spectacular gains. Today most frozen food distributors carry almost every worth-while specialty item as a means of increasing profits.

It is sometimes hard to differentiate between a specialty and a staple. QFF draws the line as follows—staples include all vegetables and fruits, concentrates, poultry, and fresh frozen fillets. Specialties include all pre-cooked frozen foods, prepared or breaded items, baked goods, items to be re-heated, shellfish, etc. Meats at present are on the border-line.

The success of various specialties tends to be geographic; what is popular in New York is not always a salable item in San Francisco—certain southern specialties would not sell in the North. On the other hand, advertising and promotion have helped many a floundering specialty. Waffles are a case in point.

French fried potatoes are an established specialty item that seems to have assured sales. Breaded shrimp (also classified under seafoods), seems to have a good future. Chinese and Italian dishes sell well; chicken à la king, meat pies (where reheating time is not too long), muffins, some pies and cakes, onion rings, potato puffs and similar items have their place in the country's frozen food cabinets provided the quality is good and the price realistic.

Too often specialties have been abused—especially in dishes containing meat, poultry, or seafood as an ingredient. In many cases the more expensive ingredient was far too short in quantity—and often in quality.

High mark-ups are another impediment to specialty sales. Being slower movers than some of the other frozen food categories, specialties are often made to bear the brunt of the profit lag by the distributor, who often takes his limit mark-up of 24% and by the retailer who generally takes his full 27%. Chains and large stores average 26.3% (QFF, November, 1951). Yet it has been proved that a more modest mark-up will often yield sufficient extra volume to render a higher gross profit. Many a "slow mover" might become a "fast mover" if the price were tempting enough.

Horsemeat and frozen dogfood is a specialty that has attained phenomenal sales during the past five years. Perhaps a golden rule for a specialty manufacturer to observe might be this—does my specialty serve an economic purpose? Does it save time and trouble? If the answer is yes, the specialty is usually a success.

French fried potatoes save the housewife the trouble of cutting and frying—so do onions; breaded shrimp save in preparation. Waffles eliminate batter preparation, are ready to eat in 2 min. And so on down the list.

About 3 years ago complete meals were popular and they still are used on certain airlines. But currently they are in eclipse. A high unit price which was generally more than the cost to the housewife making a similar meal herself hurt the complete meal idea. Yet its problems may some day be solved.

THE FROZEN FOOD BROKER

Far reaching and often sudden changes in the distribution system of the frozen foods industry has rendered the position of the broker a somewhat different one from that which he occupied several years ago. Direct buying by chains, the growing importance of national

This is our new brochure "Trouble Shooting with Blancol". The text includes the latest information on the elimination of difficulties commonly experienced in the manufacture of pulp and paper.

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DIVISION OF

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labels, the upsurge of concentrates, poultry, seafoods, and specialties, the introduction of second quality lines as well as the constant increase in the retail pack—all have had their effect upon the position of the broker.

In view of the greater volume of the industry and the increasing number of packers of all types, one thing seems certain: the need for the well-informed broker is greater than ever before. New avenues for service and profit have been opened up to the alert frozen food broker. Today, procurement is becoming almost as important as sales. The altering frozen food picture has, in large centers, restricted the broker's sales to distributors and under such conditions, many brokers have developed chain store accounts.

Several years ago most frozen food brokers handled carload lots of berries and fruits which were sold to their ice cream, preserving, and baking outlets. This business was supplemented by institutional vegetables, and later, by retail shipments which they sold to distributors. Any commodity besides fruits and vegetables was considered "beyond the pale." Today all this has changed.

Some large industrial buyers are supplying themselves direct; in other cases a part of the merchandise which was available in bulk form is being siphoned off into retail packages. In other cases distributors are buying direct from the packer, or the latter is selling chains directly. The concentrate deal, with the exception of institutional business, is mostly direct.

The big need today, however, is for the merchandise broker (see QFF, December, 1951, p. 43). There are 300% more packers than in 1941! There are more items than ever before, with the promise of more to come. Procurement is the great need for many packers who must buy a portion of their lines from other packers. Second quality retail merchandise is also in demand.

The entire industry stands upon the threshold of its greatest expansion; new acreage is being opened up in many growing areas, new distributive outlets are developing; the institutional business is improving. More packers want representation; many are small and need guidance. Many a straight-line bulk fruit broker of the past is now handling items he would have considered out of his field a few years ago—and making a success of them. The broker's main prerequisite for success today is maneuverability and a readiness to change.

Not long ago most brokers would have looked with abhorrence at the thought of selling chain stores. Today this is becoming common practice.

Of course, each area is different. In markets dominated by chains the broker will certainly have to sell direct if his packer wants him to. In other markets and in more rural areas the broker can best serve by selling distributors.

The growth of private labels by wholesalers, coops, and chains also offers the broker a wider opportunity for procurement business. Moreover, it is a fact that national and private label buyers, as a rule, only purchase a given portion of any particular packer's output, primarily the Fancy or A grade packs and that the packer must rely upon his brokerage outlet to market his institutional and lower grade packs.

There is a bigger place for the frozen food broker than ever before—but no longer is a telephone, a desk, and a letterhead enough. An expanding industry needs the broker more than ever—but it needs a broker who is in tune with the changing industry.

FUTURE OF THE INDUSTRY

Ever since its first issue in August, 1938, QFF has tried to keep ahead of the industry; most of its predictions have become fact.

For the next five years, QFF makes these predictions:

1. Decentralization of production will grow, thus keeping prices competitive.

2. There will be *more*, not fewer packers in all categories and there will be more private labels. Many people falsely compare frozen foods to the auto industry which started out with many makes and now has but a few. It might be more to the point to liken frozen foods to the beer trade in which industry there are now a number of national brands and many local beers, some of which do a bigger business in their own localities than that done by national brands. The same pattern will follow in frozen foods.

There will be at least 10 to 15 complete lines, perhaps another 20 sectional and local lines, packer-, distributor-, broker-sponsored or chain-owned, and an ever growing number of specialty items drawn from the seafood, poultry, meat, baked goods, and pre-cooked field. We believe that there will be, however, an increasing trend toward the amalgamation of duplicating and under-financed items, especially in the specialty fields, under well-backed, over-all brand names and that many of the single items attempting to get into cabinets today will have to be merchandised under a single name. But there will be many more packers and brands before there are fewer. Frozen foods turn over 50 to 100 times a year at retail, tastes are sectional and they vary—and besides, people always have to eat. The lure to market frozen products is stronger than ever.

There will have to be a considerable expansion in plant, freezing, processing, packaging, transportation, and similar equipment; present production facilities are inadequate to handle more than a 20% increase over present potential consumption. Suppliers will find the entire frozen foods industry the *most lucrative* and active in the entire food line.

3. Eventually, frozen food brands will fall into two categories: the widely advertised names for chain store distribution and others which will channel through distributors for independent and smaller store outlets. Distributors, despite predictions to the contrary, should increase by 10 to 15% and most of the increase should come from the ranks of cooperatives, wholesale grocers, and newly established forms of distribution such as direct-to-house operations and the home freezer-food service deal. The latter, already widely advertised via radio, should expand, encouraging case lot sales.

Despite the loss of sizable business by the direct from packer-to-chain deal, distributors should have sufficiently expanded volume to warrant larger operations, plus the fact that many alert distributors today are selling over 300 items. The direction in which chains will go seems clear. Volume will increase yearly, but as far as chain labels are concerned these will probably be restricted solely to fast-moving items such as concentrates, peas, strawberries, and a few others. Com-

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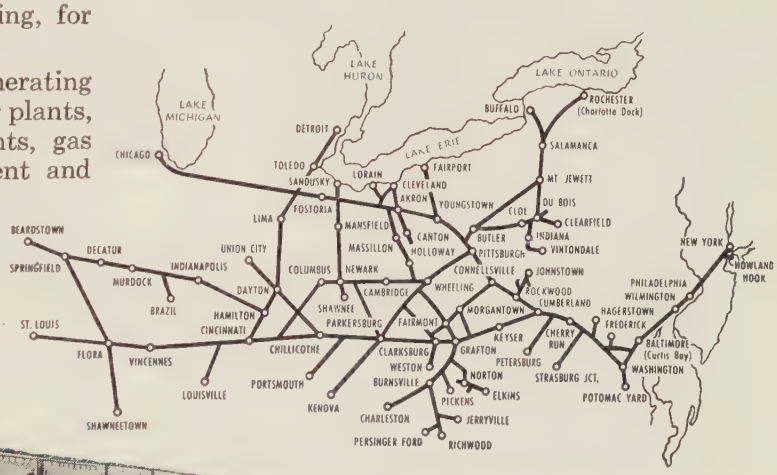
B&O coals are excellent for generating steam in utility and industrial power plants, for steel mills, malleable iron plants, gas plants, lime and brick kilns, cement and glass plants, and potteries.

Whatever your "burning need," Industrial or Domestic, there's a B&O coal to meet it—and we are ready to help you find the best for your purpose. Just *ask our man!*

BITUMINOUS COALS FOR EVERY PURPOSE



LINKING 13 GREAT STATES WITH THE NATION ® B&O

BALTIMORE & OHIO RAILROAD

Constantly *doing things*—better!

plete line chain labels do not seem likely. An increase in the "drayage" or trucking deal from warehouse to chain seems likely also.

4. Private label packing will increase but most packers will continue to make an effort to keep their own brands active.

5. The big trend in production is toward the retail package and this should continue unabated. Today the demand for retail sizes by national brands is the most important part of the frozen foods industry.

Five years ago there was only one brand of any national consequence—Birds Eye. Today, while Birds-Eye still does the biggest individual business on vegetables and fruits, other names are competing for public favor: Snow Crop, Libby, Honor Brand, PictSweet, Cedergreen, Blue Goose (in concentrates, Minute Maid and SunKist), etc. Regional brands, too, have grown: Seabrook, Dulany, Fairmont, Flav-R-Pac, Little America, Dewkist, Booth, Tree-Top, Prime Frozen, Year Round, Fair Acres, Frostcraft, Garden Gate, Donald Duck, Cortley, 19c, Top Frost, etc.

6. The impact which B-grade "economy" brands will have should not be underestimated. QFF predicts that within five years B brands will do 30 to 40% of the vegetable and fruit business, without hurting, but rather helping A grades. It will further revolutionize packing procedures, shifting the emphasis in processing from minute specifications to color and flavor. To avoid the danger of below B-grade packs flooding the market, new packing outlets may have to be established geared to emphasize B packing more than is currently possible under established setups.

7. California, the Midwest, Florida, the South, Texas, and the Rio Grande Valley should become more important producing centers for fruits and vegetables.

8. Whether it likes it or not, the frozen foods industry in the next five years will have to get into the cabinet deal as a means of breaking the cabinet bottleneck in retail stores. It will not be long before almost every distributor will sponsor some kind of deal facilitating the placement of cabinets in stores, and packers having a national distribution will also have to have cabinets available to distributors on long-term financing.

Retail stores doing a good sized volume will need at least four to five cabinets: one for vegetables and fruits, one for concentrates, one for seafoods and poultry and another for meats and specialties. Backroom zero storage space will also become more of a necessity than ever in many stores.

9. More and more related industries, such as meat, poultry, seafoods, and others will come under the common denominator of quick freezing—will become more active members of the industry.

10. Price cutting will not abate until there is more zero space in retail stores. Prices should not rise to any great extent during the next 18 months.

11. More "big money" will be attracted to the industry and profits of both packers and distributors should increase with volume. By the end of 1952, with lower raw material prices and barring unnecessary price wars, the concentrate industry should be on a profitable basis.

REPRINTED from the March, 1952, issue of *Quick Frozen Foods*.

Improve Your Products with Permutit Equipment

THE PERMUTIT PRECIPITATOR removes turbidity, color, iron and manganese from process waters . . . banishing stains, off-shades and dullness. Full utilization of the sludge-blanket principle enables you to save up to 40% on chemicals, while supplying a perfectly clear effluent that's ideal for production of high brightness pulps and papers.

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PERMUTIT'S FULL LINE of water conditioning equipment includes Filters, Automatic Zeolite Softeners, Aerators and Degasifiers, and Deaerating Heaters.

For full information on any or all of these Permutit water conditioners, write to The Permutit Company, Dept. TAP-2, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance St., Montreal.

WATER CONDITIONING HEADQUARTERS FOR OVER 40 YEARS

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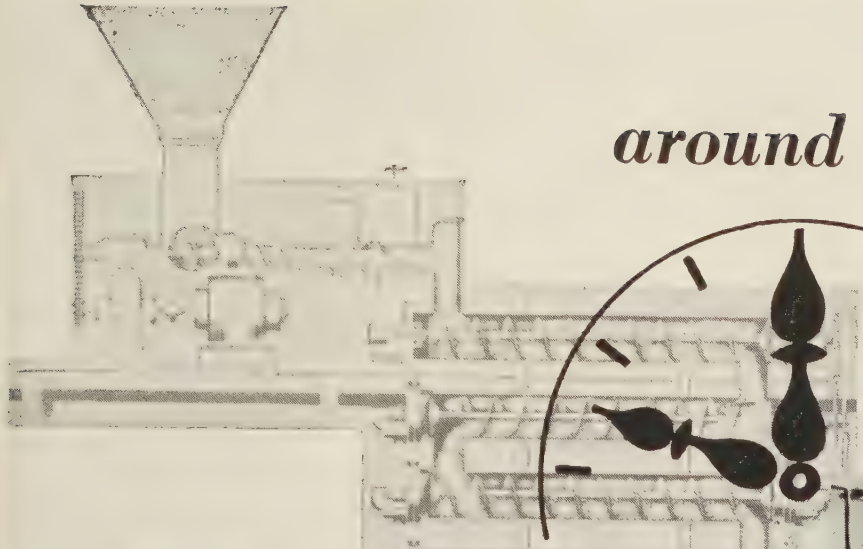
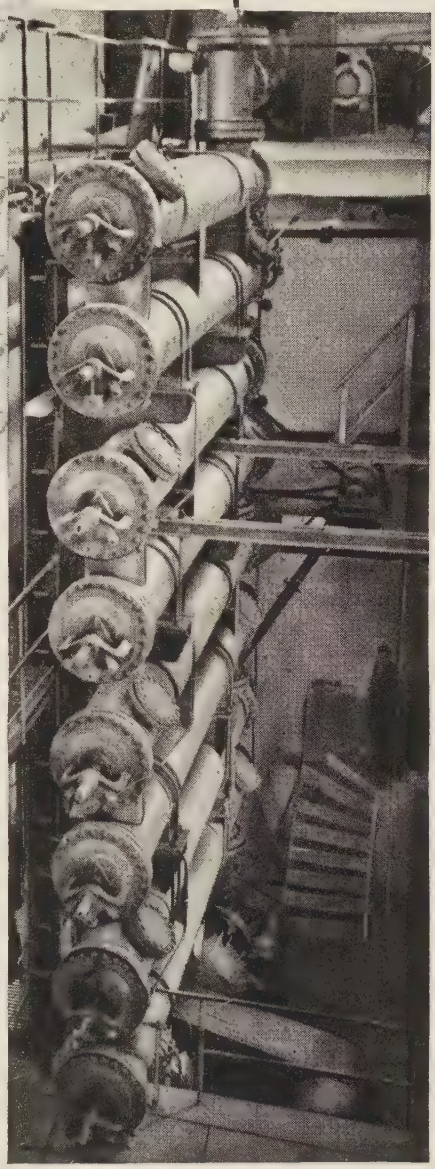
around the clock



CHEMI-PULPER®

continuous digester



More and more mills using CHEMI-PULPER continuous digesters for their around-the-clock pulp mill operation report the continuous production of uniform, high grade pulp at the lowest possible cost.

CHEMI-PULPER continuous digesters have been built in sizes from 2 to 8 tubes with various diameters. The largest of these units are capable of producing over a 100 tons of pulp per day. Some are equipped with the new Pandia Discharger which continuously and uniformly discharges pulp at a constant rate from the CHEMI-PULPER continuous digester to the atmosphere.

The 8-tube CHEMI-PULPER continuous digester shown here is an installation in Finland which was placed in operation during the Summer of 1951 and feeds primarily on waste spruce and pine from a sawmill. This unit is fabricated of 316 stainless steel which permits the use of alkaline or acid cooking liquors. Because of the CHEMI-PULPER continuous digester's basic construction and flexibility of operation, the 8-tube unit can produce pulps over a wide yield range.

CHEMI-PULPER continuous digesters are being used universally to convert hard or soft woods or mixtures of these woods into superior pulps for insulating board, flooring, roofing and automotive felts, and .009 corrugating and other types of boards and papers.

One of Pandia's engineers will be glad to consult with you concerning plans for new plant construction or for improving present pulp mill operation.

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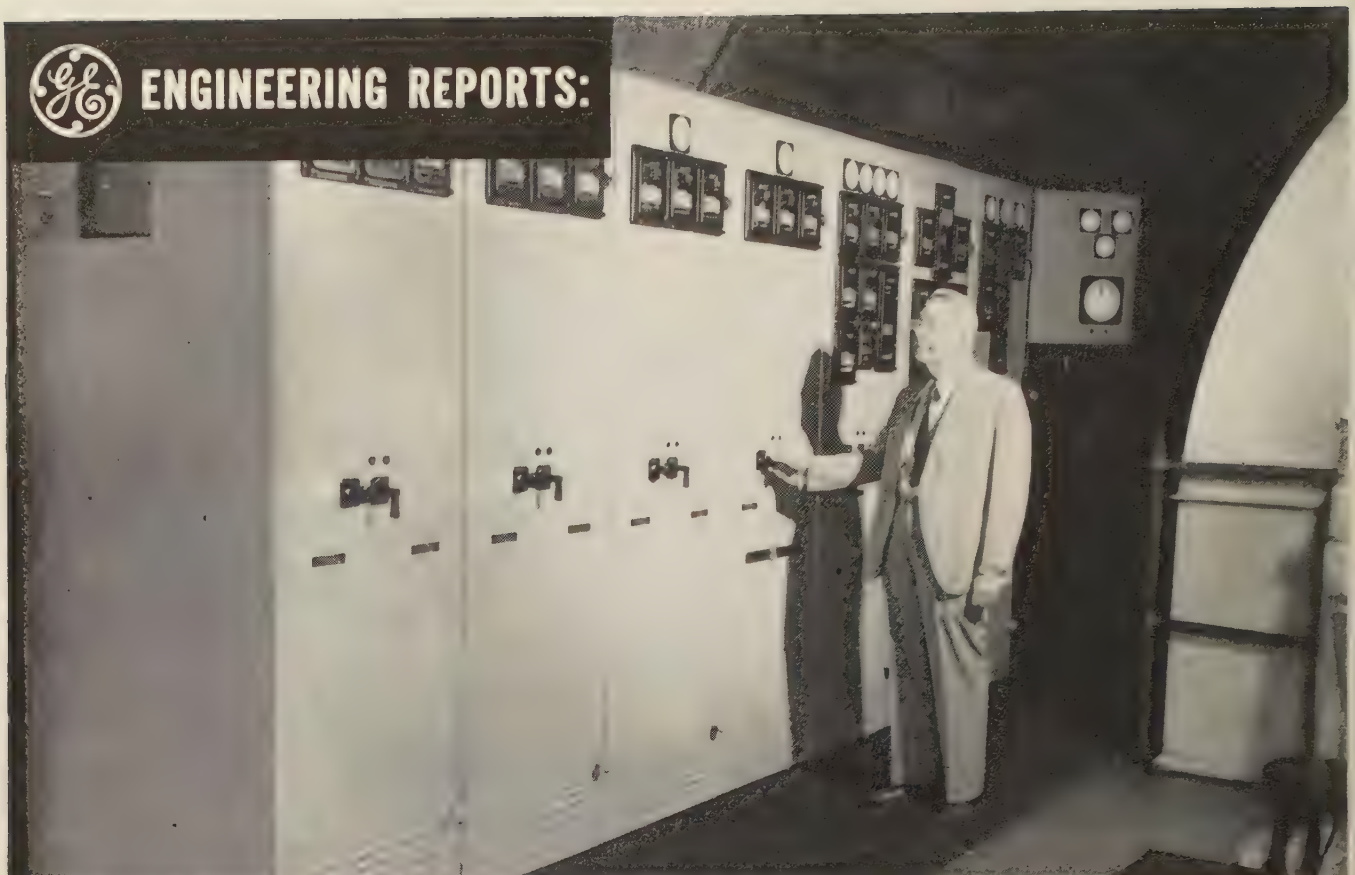
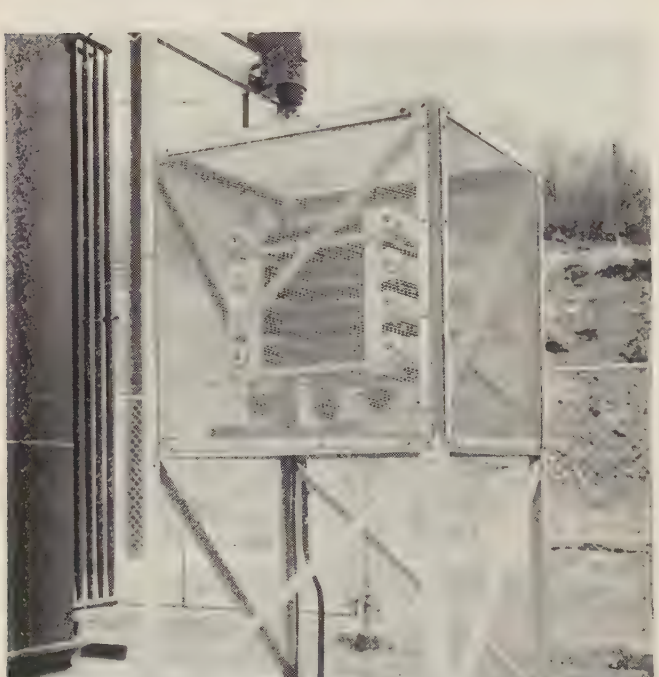


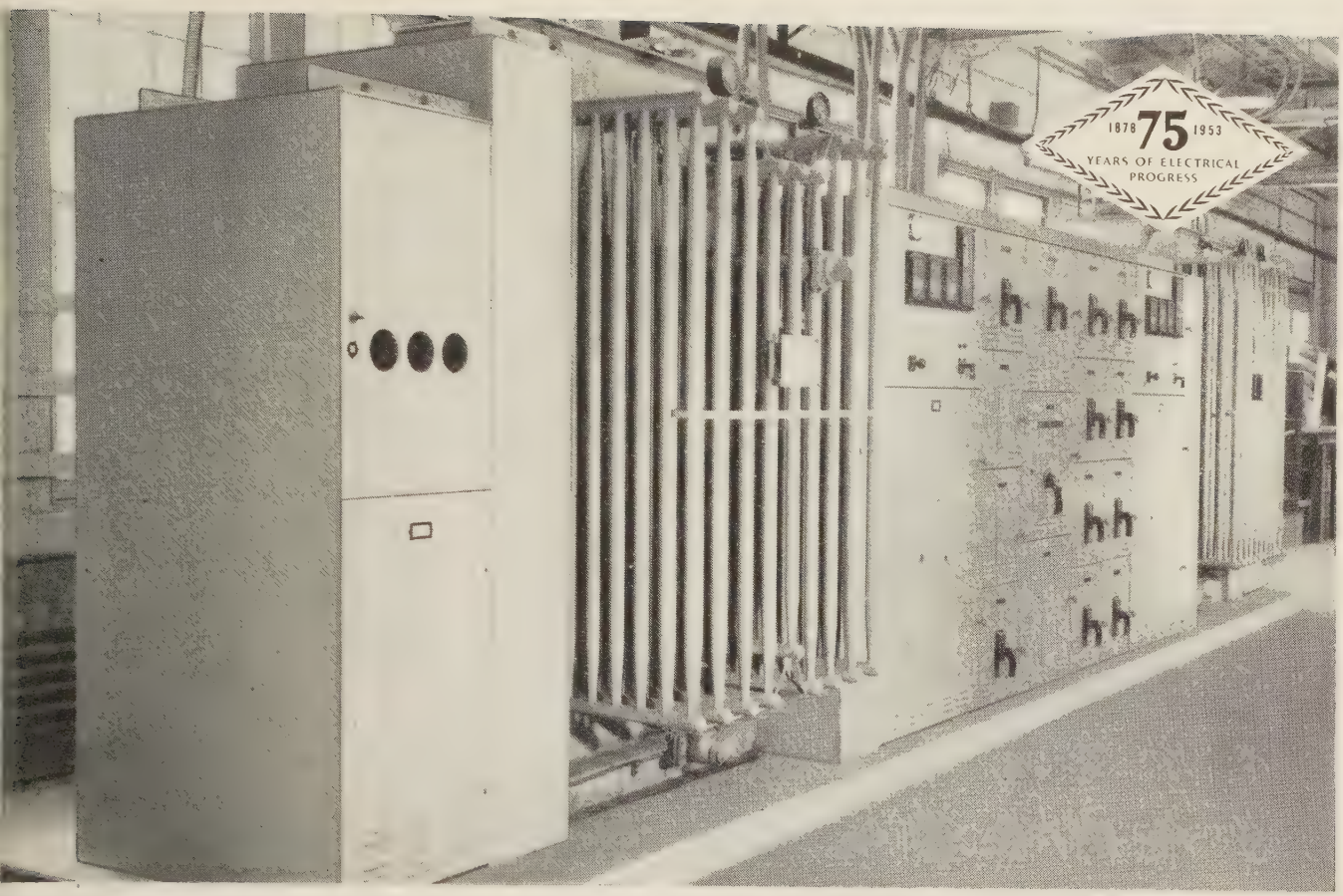
AMPLE IC. G-E metal-clad switchgear at Gardner has ample interrupting capacity for both present load and future expansion. Alfred Clegg, power house chief, likes the operating convenience of centralized control for main power circuits.

Modern power distribution system



NEUTRAL GROUNDING provides better over-all system operation. This resistor in the neutral of the 4160-volt system limits ground-fault current minimizing damage to equipment.

G-E APPLICATION ENGINEERS, with tools like this portable analyzer, can study your entire power system quickly—and recommend the proper system for your present and future load.



PROTECTS PRODUCTION. This 3000-kva G-E double-ended unit substation is one of two that insure against complete shutdown in stock preparation areas by providing an alternate 480-volt power source via secondary-selective arrangement.

protects production at Gardner

Secondary selective arrangement also adds flexibility for future expansion, more safety for personnel—neutral grounding minimizes equipment damage due to ground faults

Recently the Gardner Board and Carton Company of Lockland, Ohio, realizing that modern paper-making machinery does a continuous, high-tonnage job only when supplied continuously with adequate electric power, modernized its plant's power distribution system. Completely engineered and equipped by General Electric on an economical step-by-step basis, the new system includes such modern engineering advances as these:

"Building-block" load-center unit substations that reduce power distribution costs and make future expansion easier—factory-assembled metal-clad switchgear that cuts installation cost and protects equipment and feeders—high-voltage power distribution for full voltage at the motors and higher operating efficiency—a secondary selective arrangement that safely provides a dual power-supply route for greater reliability and continuity of production—and neutral grounding of both the 4160- and 480-volt systems for greater safety to personnel and lower over-all downtime for outages.

Let your local G-E apparatus sales representative tell you how G-E engineers can analyze your entire power system quickly, and help you select the proper equipment to fit your plant's needs.

Meanwhile, write for bulletin GEA-5521, "Power System Equipment for Pulp and Paper Mills" and technical article GET-1181C, "Neutral Grounding of Industrial Power Systems." Section 655-12, General Electric Company, Schenectady 5, N. Y.

Engineered Electrical Systems for Paper Mills

GENERAL ELECTRIC

PULP, PAPER, AND BOARD—ECONOMIC REVIEW

W. LE ROY NEUBRECH

By the end of 1952 practically all NPA control orders materially affecting the operations of the pulp, paper, and board industry will have been revoked except in the field of metals especially those under the Controlled Materials Plan (CMP).

When supplies of wood pulp showed evidence of meeting requirements in the early part of 1952 the NPA immediately consulted with industry though appropriate Industry Advisory Committees and recommendations were made for dispensing with Order M-72—Chemical Wood Pulp. This order was revoked, effective April 8, 1952. Following the NPA decontrol action on pulp, the Office of International Trade of the Department of Commerce discontinued, effective Aug. 14, 1952, all export quotas and controls on wood pulp to most countries, excepting dissolving grades which remained on the positive list and would still require export licenses.

Although more adequate supplies of paper and paperboard became available by mid-1952, it was the consensus of the Industry Advisory Committee at that time that NPA order M-36—Government Orders for Paper, should be kept operative until it was more definite that Federal agencies would not encounter difficulties in obtaining essential paper requirements. However, at the meeting of the Pulp, Paper and Paperboard IAC on Nov. 5, 1952, it was pointed out that the Government "take" under M-36 had declined to only 2.1% of production in October and that D.O. rated orders for paper, accepted by mills under M-36, were only one-half of 1% of production in October. Notwithstanding the fact that primary paper and paperboard will continue subject to D.O. ratings issued by the Department of Defense and Atomic Energy Commission and certain other special ratings under the provisions of Direction 3 of NPA Reg. 2—Basic Rules of the Priorities System, it was recommended that M-36 be revoked. It is expected that by Dec. 31, 1952, this action will be accomplished.

Two orders of the Chemical Division of NPA, which were of considerable concern to the pulp industry, have also been revoked. They were NPA orders M-69 on sulphur, revoked Nov. 5, 1952, and M-31 on chlorine, revoked Nov. 18, 1952.

The U. S. pulp, paper, and paperboard industry entered the fourth quarter with renewed optimism brought about through substantially increased demand for paper and paperboard, following the inventory readjustment period of earlier months. The inventory cycle in paperboard took approximately a year (from July, 1951, through July, 1952) following the heavy buying which took place in the last half of 1950 and the first 6 months of 1951. In the case of paper, the inventory adjustment was less severe as to its effect upon production and apparently ran its course from March through September, 1952.

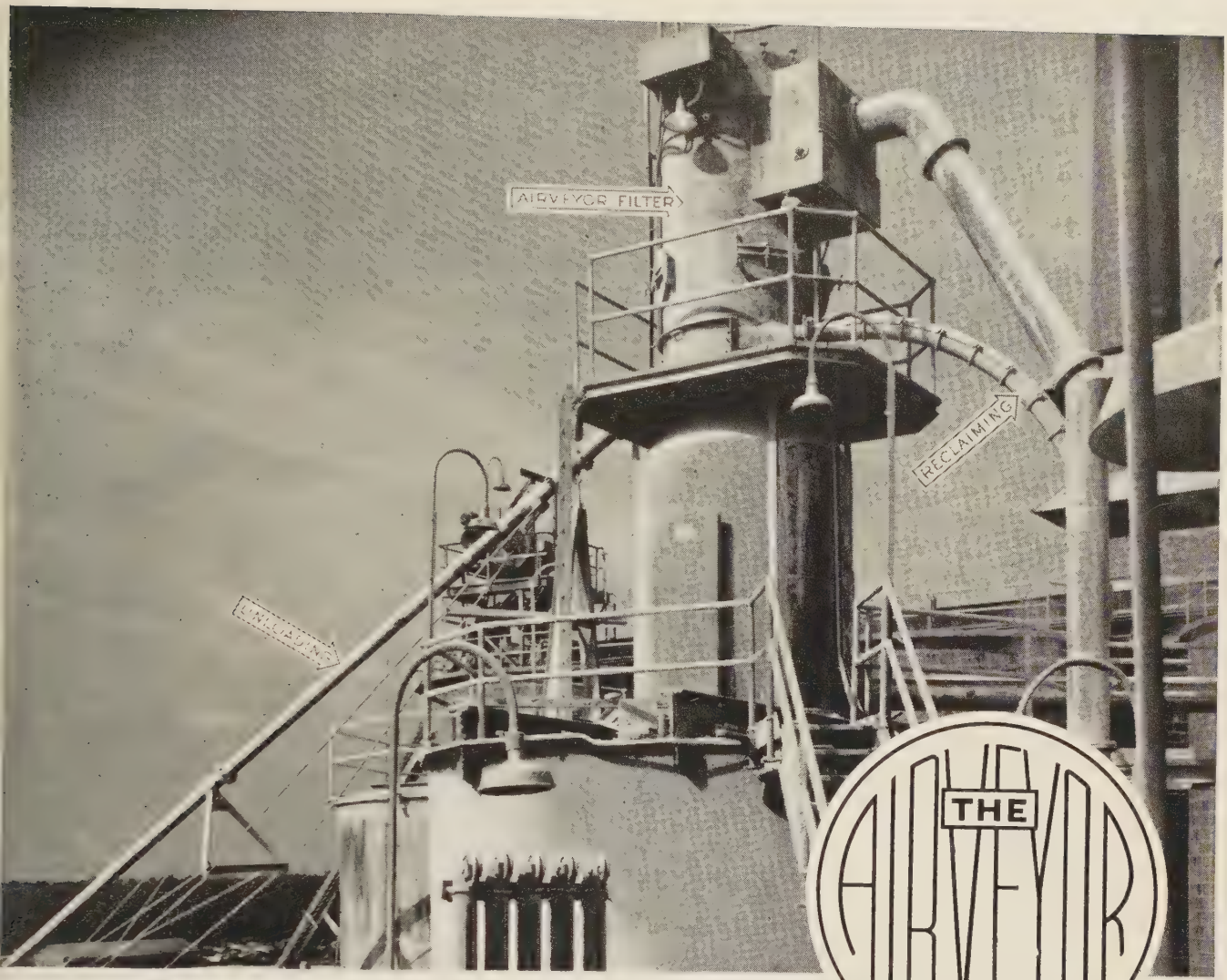
Inventory cycles long have been known to be a major economic factor causing ups and downs in production, employment, and prices in most fields of industry and business. Numerous studies have been made on this subject for various commodities. Only recently, analyses of the inventory cycles of paper, paperboard, and wood pulp have been made by industry observers—a sort of look backward at what had happened to the market in the months gone by. To benefit from historical experience means that in the future there should be an alertness to the situation as it is "in the making" and not after "it is too late." It would seem that much could be accomplished strictly on a voluntary basis provided individual producers, converters, distributors, and consumers could be adequately informed of the current position of supply, consumption, and inventories so as to individually judge their own course of policy and action on purchases and inventories. Providing the majority of individuals made the right decision, the length of inventory cycles could be reduced to the benefit of all. Such independent action should be an important element in maintaining production, distribution, consumption, and prices at a steadier level and assist in smoothing out the historical bumps not brought about by other underlying factors.

W. Le Roy Neubrech, Assistant to Director, Pulp, Paper, and Paperboard Div., National Production Authority, U. S. Dept. of Commerce, Washington.

Table I. Statistical High Lights

Item and unit	First 9 months 1952	First 9 months 1951	Change, %
Pulpwood:			
Receipts, 1000 cords	20,676	20,875	−1.0
Consumption, 1000 cords	19,731	19,732	....
Inventories (end of period), 1000 cords	5,999	4,980	+20.5
Wood pulp (total integrated and market):			
Production, 1000 short tons	12,259	12,333	−0.6
Imports, 1000 short tons	1,343	1,825	−26.4
Exports, 1000 short tons	176	137	+28.4
New supply,[a] 1000 short tons	13,426	14,021	−4.2
Consumption, total, 1000 short tons	13,369	13,819	−3.3
Paper and board, 1000 short tons	12,823	13,295	−3.6
Nonpaper, 1000 short tons	546	524	+4.2
Inventories, total (end of period), 1000 short tons	746	675	+10.5
Pulp, 1000 short tons	135	105	+28.6
Paper and board, 1000 short tons	519	497	+4.4
Nonpaper, 1000 short tons	92	73	+26.0
Market wood pulp (at paper and board mills):			
Receipts, 1000 short tons	1,648	2,151	−23.4
Consumption, 1000 short tons	1,661	2,082	−20.2
Inventories (end of period), 1000 short tons	368	397	−7.3
Market wood pulp (at nonpaper mills):[b]			
Receipts, 1000 short tons	561	537	+4.5
Consumption, 1000 short tons	546	524	+4.2
Inventories (end of period), 1000 short tons	92	73	+26.0
Wastepaper:			
Receipts, 1000 short tons	5,645	7,334	−23.0
Consumption, 1000 short tons	5,733	7,163	−20.0
Inventories (end of period), 1000 short tons	497	577	−13.9
Paper and board production:			
Paper, 1000 short tons	8,181	8,637	−5.3
Paperboard, 1000 short tons	7,795	9,104	−14.4
Wet machine, 1000 short tons	100	115	−13.0
Construction paper and board, 1000 short tons	1,924	2,118	−9.2
Total	18,000	19,974	−9.9
Wholesale paper and paper products:			
Sales, $1,000,000	1,629	1,828	−10.9
Inventories (end of period), $1,000,000	261	251	+4.0

[a] New supply equal production plus imports minus exports.
[b] Data not comparable, 1952 data represent more complete coverage of this industry.
Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from Bureau of the Census, U. S. Department of Commerce.



Efficient - - - economical handling of lime and salt cake at Hudson Pulp & Paper, Palatka Plant

Again, the Airveyor was selected and installed in another paper mill . . . the new 10 million dollar unit of the Hudson Pulp & Paper Corporation at Palatka, Florida. One of the newer paper mills in the South, which first started operation in November, 1947, has more than doubled its production.

The handling of raw materials, in an efficient and economical manner, was highly essential in such a modern operation. The unloading and storing of lime and salt cake was one of the problems to be considered. Two Airveyors are in use at Palatka. One system unloads and reclaims salt cake, and the other handles the pebble lime. The salt cake system unloads from box cars at rate of 10 tons an hour, conveying to storage bins; also conveys this same material from a truck-dump hopper to a bin. The same system reclaims from bins and delivers to a mixer. The pebble lime system unloads from box cars at rate of 7½ tons an hour and conveys to storage bins. It also reclaims at the same rate, for delivery to process.

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A-144

Table II. Pulpwood—Receipts, Consumption, and Inventories

(1000 Standard Cords—Roughwood Basis)

Item	1952 3d qtr.[a]	1952 2d qtr.	3d qtr. 1951	First 9 months 1952	First 9 months 1951	Change, %
Receipts, total	7087	5847	7318	20,676	20,875	−1.0
Domestic	6344	5412	6491	18,829	18,872	−0.2
Imported	743	435	827	1,847	2,003	−7.8
Northeast, total	1580	841	1522	3,917	3,740	+4.7
Domestic	1033	607	967	2,732	2,490	+9.7
Imported	547	234	555	1,185	1,250	−5.2
Appalachian, total	285	426	470	1,209	1,523	−20.6
Domestic	285	426	470	1,209	1,523	−20.6
Lake States, total	647	410	837	2,415	2,600	−7.1
Domestic	451	252	607	1,816	1,987	−8.6
Imported	196	158	230	599	613	−2.3
South, total	3180	3136	3157	9,841	9,543	+3.1
Domestic	3180	3136	3157	9,841	9,543	+3.1
West, total	1395	1034	1332	3,294	3,469	−5.0
Domestic	1395	991	1290	3,231	3,329	−3.0
Imported	....	43	42	63	140	−55.0
Consumption, total	6224	6609	6520	19,731	19,732	.....
Northeast	927	1032	1033	3,049	3,182	−4.2
Appalachian	363	453	454	1,276	1,394	−8.5
Lake States	679	706	727	2,153	2,271	−5.2
South	3197	3291	3221	9,902	9,550	+3.7
West	1058	1127	1085	3,351	3,335	+0.5
Inventories, total[b]	5999	5149	4980	....	....	+20.5
Northeast	2125	1609	1563	....	....	+36.0
Appalachian	370	378	392	....	....	−5.6
Lake States	1686	1702	1325	....	....	+27.2
South	730	747	774	....	....	−5.7
West	1088	713	926	....	....	+17.5

[a] Preliminary. [b] End-of-quarter.
Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

Probably no other industry has been any more alert or progressive in the area of current (monthly and weekly) statistics than the U. S. pulp, paper, paperboard, and related industries. However, for the most part, these statistics have been in the field of production, orders, and shipments. While certain statistical series show the status of inventories, there are very few product fields where the series are sufficiently complete to make a suitable appraisal. Two examples of practically complete inventory data are woodpulp and newsprint where the statistical facilities of the industry associations coupled with those of the Bureau of the Census, Department of Commerce, serve to supply all significant data from the producing level to the ultimate consuming level. It is true, of course, that in many other product fields there are more stages of manufacture and distribution and perhaps a wider range of consumers, which would entail greater effort to get more complete current data on inventories. In some areas, inventories are measured in dollars which is not as good a measuring unit as physical quantities especially when sharp price fluctuations are taking place. Further exploration of the possibilities for even better and more useful current statistical coverage would appear timely. In the future there should not be a dependence upon rumors and guesses when it comes

Table III. Wood Pulp—Production and Pulp Mill Inventories

(1000 Short Tons)

Item	1952 3d qtr.[a]	1952 2d qtr.	3d qtr. 1951	First 9 months 1952	First 9 months 1951	Change, %
Production, total	3891	4122	4058	12,259	12,333	−0.6
Sulphite, total	718	781	751	2,307	2,332	−1.1
Bleached	564	610	576	1,797	1,767	+1.7
Unbleached	154	171	175	510	565	−9.7
Sulphate, total	2006	2124	2123	6,369	6,403	−0.5
Bleached	485	543	477	1,569	1,366	+14.9
Semibleached	69	67	71	204	264	−22.7
Unbleached	1452	1514	1575	4,596	4,773	−3.7
Soda	92	110	105	318	333	−4.5
Groundwood, bleached and unbleached	573	613	600	1,796	1,868	−3.9
Semichemical	205	196	188	588	550	+6.9
Defibrated or exploded	264	264	256	778	734	+6.0
Screenings, damaged, etc.	33	34	35	103	113	−8.8
Inventories, total[b]	135	148	105	.....	.....	+28.6
Sulphite, total	63	65	38	.....	.....	+65.8
Bleached	49	51	27	.....	.....	+81.5
Unbleached	14	14	11	.....	.....	+27.3
Sulphate, total	36	33	28	.....	.....	+28.6
Bleached	13	15	13	.....	.....	.....
Semibleached	1	1	1	.....	.....	.....
Unbleached	22	17	14	.....	.....	+57.1
Soda	3	3	2	.....	.....	+50.0
Groundwood, bleached and unbleached	24	37	32	.....	.....	−25.0
Semichemical, Defibrated or exploded, Screenings, damaged, etc.	9	10	5	.....	.....	+80.0

[a] Preliminary. [b] End-of-quarter.
Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

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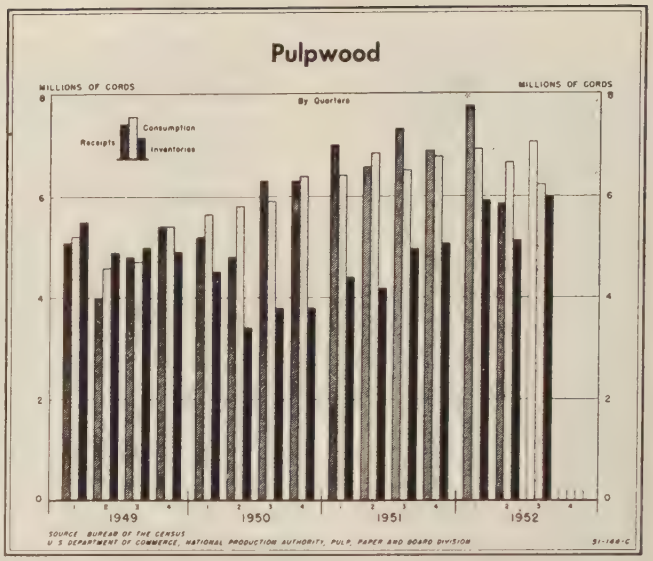
to one of the fundamental tools of management—namely current statistics.

Demand for most grades of paper and paperboard strengthened greatly in September, October, and early November following the slackness of the summer months partly caused by seasonal factors. The quickened pace of general economic activity which started in September due to the normal seasonal pickup coupled with recovery in the industry segments affected by the steel shutdown was a major contributing factor to the buying interest in paper and paperboard. The other significant factor was the fact that inventories, particularly paperboard, in the hands of distributors, converters, and consumers, had been adjusted downward in preceding months to more practical levels. However, according to trade reports from Commerce Department field offices, inventories of many grades of paper in merchants' warehouses were still on the heavy side at the end of September, but in view of a large volume of current sales the pressure of merchant inventories became a less significant factor than otherwise would have been the case.

Wholesale paper merchants' sales in September rose to $198 million, according to Commerce Department data, the highest monthly sales recorded during any month of 1952. This higher level of sales brought inventories down to $261 million at the end of September, or somewhat lower than the high point of $274 million reached at the end of May 1952. (Refer to Table XI.)

There appears to be a growing tendency for retailers and ultimate consumers of paper to keep inventories at a lower level and rely upon the merchants to carry sufficient stocks to permit immediate delivery upon demand. A similar situation is reported to have developed with regard to many merchants who recently were depending more and more on the mills for spot deliveries rather than increase their stocks. Such a situation often develops during a period of declining demand when a buyers' market exists.

Now that the market has strengthened and deliveries from many mills extended to as much as 60 days or more, there may again develop a tendency toward another inventory buying cycle. More caution is anticipated, however, since there are not the "scare" elements which existed in late 1950 and most of 1951. In fact, the majority of private long range economic forecasts appearing in the public press have



pointed to a possible economic slackening in 1953 which may cause many buyers to be more conservative. A moderate conservative restraint on inventory buying in the current period should result in avoiding another inventory cycle and as a consequence a steady and healthy paper and paperboard market during the coming months.

Commerce Department field office reports indicate that during the summer months wholesale merchants' competition in a number of converted products such as paper napkins, towels, toilet tissue, plates, and bags, was more pronounced than in basic paper itself.

The summer period of lowered volume for both coarse and fine paper merchants caused considerable apprehension because of the higher costs of operating wholesale warehouses including such items as freight, trucking, and labor. The narrowed profit margins were reported particularly disturbing in view of price competition. Now that a larger volume of business is again at hand it will offset to some degree these increased operational costs.

In the third quarter of 1952 Census data disclosed that

Table IV. Wood Pulp—Consumption and Inventories at Paper and Board Mills

(1000 Short Tons)

Item	1952		3d qtr.	First 9 months		
	3d qtr.[a]	2d qtr.	1951	1952	1951	Change, %
Consumption, total	4088	4282	4334	12,823	13,295	−3.6
Sulphite, total	700	759	775	2,278	2,474	−7.9
Bleached	466	502	494	1,501	1,564	−4.0
Unbleached	234	257	281	777	910	−14.6
Sulphate, total	2141	2245	2283	6,755	6,966	−3.0
Bleached	581	632	587	1,855	1,714	+8.2
Semibleached	76	73	80	225	292	−23.0
Unbleached	1484	1540	1616	4,675	4,960	−5.8
Soda	102	117	116	345	369	−6.5
Groundwood, bleached and unbleached	640	666	681	1,970	2,084	−5.5
Semichemical	206	196	188	588	548	+7.3
Defibrated or exploded	264	264	254	779	731	+6.6
Screenings, damaged, etc.	35	35	37	108	123	−12.2
Inventories, total[b]	519	552	497	.....	.....	+4.4
Sulphite, total	225	249	209	.....	.....	+7.6
Bleached	122	137	95	.....	.....	+28.4
Unbleached	103	112	114	.....	.....	−9.6
Sulphate, total	242	243	211	.....	.....	+14.7
Bleached	155	149	103	.....	.....	+50.5
Semibleached	11	10	7	.....	.....	+57.1
Unbleached	76	84	101	.....	.....	−24.8
Soda	15	16	14	.....	.....	+7.1
Groundwood, bleached and unbleached	29	36	53	.....	.....	−45.3
Semichemical, Defibrated or exploded, Screenings, damaged, etc.	8	8	10	.....	.....	−20.0

[a] Preliminary. [b] End-of-quarter.

Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

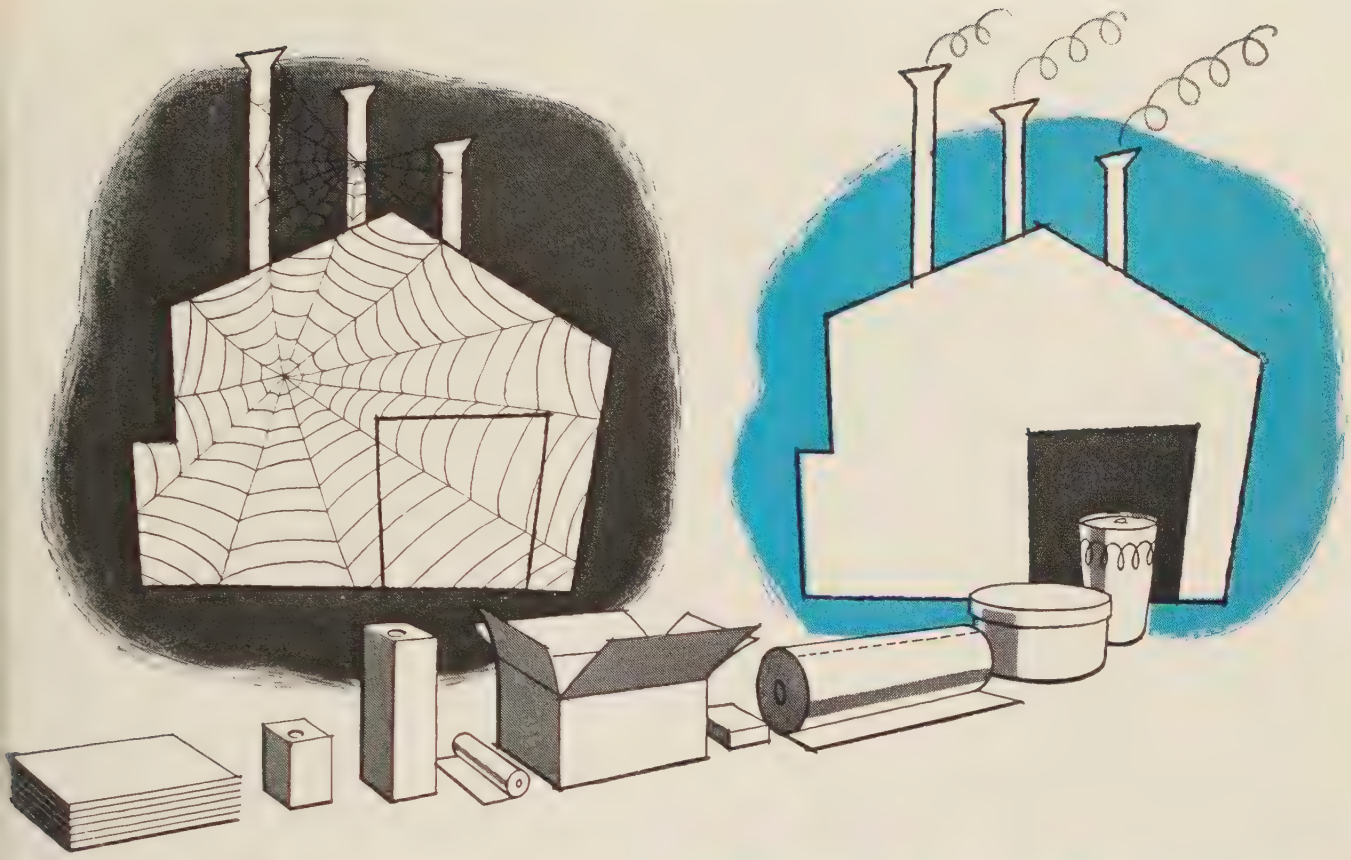


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Table V. Market Wood Pulp—Paper and Paperboard Mills Only[a]

(1000 Short Tons)

Item	1952 3d qtr.[b]	1952 2d qtr.	3d qtr. 1951	First 9 months 1952	First 9 months 1951	Change, %
Wood pulp, total all grades:						
Receipts, total	474	551	708	1648	2151	−23.4
Domestic	237	288	326	834	954	−12.6
Imported	237	263	382	814	1197	−32.0
Canada and Newfoundland	182	217	273	636	803	−20.8
European	55	46	109	178	394	−54.8
Consumption (purchased pulp), total	504	538	654	1661	2082	−20.2
Inventories (purchased pulp), total[c]	368	404	397	368	397	−7.3
Domestic shipments, total[d]	238	259	320	802	934	−14.1
Sulphite, all grades:						
Receipts, total	235	288	344	837	1060	−21.0
Domestic	125	158	172	449	519	−13.5
Imported	110	130	172	388	541	−28.3
Canada and Newfoundland	86	108	123	307	379	−19.0
European	24	22	49	81	162	−50.0
Consumption, total	248	271	316	826	1039	−20.5
Inventories, total[c]	192	210	181	192	181	+6.1
Domestic shipments[d]	125	135	170	422	511	−17.4
Sulphate, all grades:						
Receipts, total	157	182	248	554	713	−22.3
Domestic	73	90	107	259	277	−6.5
Imported	84	92	141	295	436	−32.3
Canada and Newfoundland	61	70	88	211	240	−12.1
European	23	22	53	84	196	−57.2
Consumption, total	170	177	220	556	679	−18.1
Inventories, total[c]	133	147	149	133	149	−10.7
Domestic shipments[d]	76	85	110	264	291	−9.3
Groundwood and other grades:						
Receipts, total	82	81	116	257	378	−32.0
Domestic	39	40	47	126	158	−20.3
Imported	43	41	69	131	220	−40.5
Canada and Newfoundland	35	39	62	118	184	−35.9
European	8	2	7	13	36	−63.9
Consumption, total	86	90	118	279	364	−23.4
Inventories, total[c]	43	47	67	43	67	−35.8
Domestic shipments[d]	37	39	40	116	132	−12.1

[a] Market pulp consists of domestic or imported pulp purchased from a mill not under the same ownership control as the purchaser. [b] Preliminary. [c] End-of-quarter. [d] Shipments by domestic pulp mills to domestic paper and paperboard mills. The difference between shipments and receipts may be explained in part by "in transit" pulp and probably incomplete reports on domestic shipments.

Note: Data on imports from Canada and Newfoundland also includes shipments from all other North American countries, such as Mexico; data on imports from Europe also include shipments from all overseas sources.

Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

paperboard production recovered materially from the low level second quarter, whereas paper showed a substantial decline.

For the first 9 months of 1952, however, paperboard production was 14.4% below the same period of 1951, while paper output declined only 5.3% in similar comparison. For the industry as a whole (all types of paper and board) 9 months' production this year was approximately 10% under the 1951 period. It now appears reasonably safe to forecast that the industry's output in 1952 will be approximately 24 million tons compared to the record-breaking production of 26 million tons in 1951 and the previous high of 24.4 million tons in 1950.

Table VI. Wood Pulp—Dissolving and Special Chemical Grades of Wood Pulp[a] in Other than Paper and Board Manufacture[b]

(In Short Tons)

Item	3d qtr. 1952	2d qtr. 1952	1st qtr. 1952
Receipts, total	206,438	166,576	187,499
Domestic	148,835	121,227	135,644
North American, except United States[c]	57,603	45,349	51,855
Consumption	203,880	162,172	180,373
Inventories, end-of-quarter	91,538	89,013	84,689

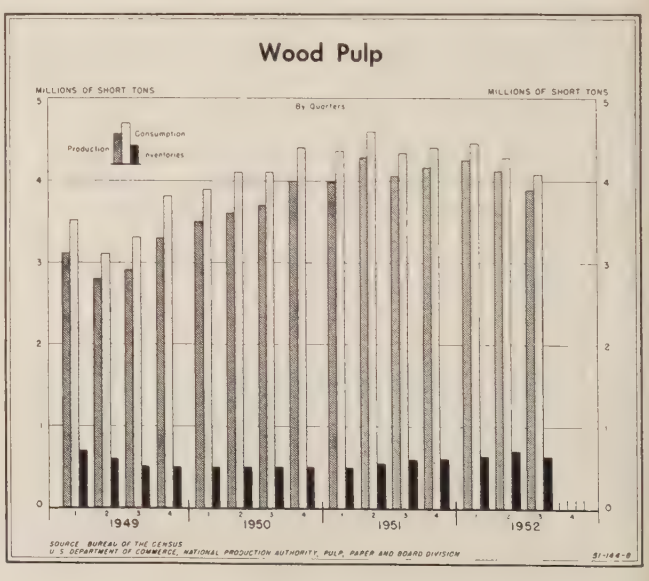
[a] Includes a small quantity of most other grades of wood pulp.

[b] Data not complete. Coverage has been increased in August, 1951, and data represent all but a small percentage of the wood pulp consumed outside paper and board industry in 1951, and include plants classified in the following industries: "Pulp good, pressed and molded," "Plastic materials," "Synthetic fibers," "Explosives," "Industrial organic chemicals, n.e.c.," "Cleaning and polishing preparations," "Wire drawing," "Surgical appliances and supplies," and "Wood Products, n.e.c."

[c] Includes a small quantity of "Overseas" sulphite.

Source: Prepared by Pulp, Paper and Paperboard Divisien, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

A review of Table IX discloses that in only three grade groups, namely, newsprint, uncoated groundwood printing papers, and chemical wood pulp fine papers, did the production in the first three quarters of 1952 exceed the same period of 1951. Substantial declines were registered for a number of important volume grade groups such as uncoated book, coarse papers, sanitary papers, paperboards of all grades, as well as construction paper and boards. But, as pointed out previously, third quarter data show material recovery over the second quarter of 1952 in a number of items, especially



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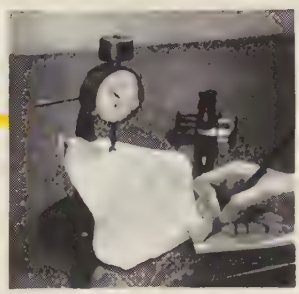

One of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products. Here fabric thickness after weaving is being gauged.

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Table VII. Wood Pulp—Imports by Grade and by Country of Origin

(Short Tons)

Item	1952 3d qtr.[a]	1952 2d qtr.	3d qtr. 1951	First 9 months 1952	First 9 months 1951	Change, %
Mechanical, unbleached[b]	60,470	56,491	71,364	168,809	248,737	−32.1
Mechanical, screenings	980	1,052	1,292	3,097	3,895	−20.5
Sulphite, unbleached	83,754	92,937	136,850	293,436	433,692	−32.4
Chemical screenings	838	902	2,495	3,179	6,896	−53.9
Sulphite, bleached, rayon and special chemical grades	57,219	44,976	55,474	151,691	170,834	−11.2
Sulphite, bleached, other	54,308	64,624	84,232	196,161	272,801	−28.1
Sulphate, unbleached	42,564	34,894	76,592	130,781	276,624	−52.7
Sulphate, bleached	115,192	124,871	131,330	374,691	385,991	−2.9
Soda pulp	6,350	7,045	8,102	20,895	25,317	−17.5
Total	421,675	427,792	567,731	1,342,740	1,824,787	−26.4

Month 1952	Total	Canada[c]	Sweden	Finland	Norway	Others
July	122,636	111,687	5,827	4,676	442	4
August	138,616	118,980	9,940	9,105	591	....
September	160,423	128,105	20,955	10,612	751	....
Total—9 months, 1952	1,342,740	1,161,686	96,896	72,482	11,384	292
Total—9 months, 1951	1,824,787	1,412,911	222,156	153,777	29,669	6,274

[a] Preliminary.
[b] Including bleached mechanical.
[c] Including Newfoundland.
Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

in a container board, folding boxboard, and construction boards.

Domestic wood pulp production continued steady this year, notwithstanding the decline in paper and board production. In fact, production for the first three quarters was less than 1% below the same period of 1951. This condition was possible because import purchasing of pulp declined more than 26%, exports increased, and inventories were built up 10.5% at the end of September over the same date in 1951. In terms of volume, imports of wood pulp dropped nearly 500,000 tons in 1952 against the first 9 months of 1951. During this same comparable period, exports in 1952 were nearly 40,000 tons, or 28%, larger than in 1951. At the same time inventories at pulp mills, paper and board mills, and at nonpaper mills were enlarged by about 70,000 tons over a year ago.

Another significant observation with respect to wood pulp is that total domestic consumption (by paper and board mills and by nonpaper consumers) declined only 450,000 tons, or 3.3%. On the other hand, consumption of purchased (market) pulp by nonintegrated paper and board mills *alone* declined 421,000 tons, or more than 20%. In view of the stronger demand for paper and board in the fourth quarter, it is likely that the nonintegrated mills will show a substantial upturn in pulp consumption and that pulp purchases will be increased, with a probable interest in strengthening inventories for the winter and early spring period. However, nonintegrated paper and board mills inventories at the end of September were equal, on the average, to about 2½ months' requirements and certainly not at a dangerously low level.

In the field of dissolving wood pulp, consumption in the three quarters of 1952 by nonpaper mills was up 22,000 tons and inventories at the end of September were up 19,000 tons compared to a year ago. The major consumer of dissolving pulp is the rayon and acetate industry which has encountered a strong improvement in demand since the relatively low level of operations in the first seven months of 1952. In fact, production of rayon and acetate yarn, staple, and tow in September was at a rate of 86% of capacity and in October at 83%, compared to only 70% in the first quarter and 66% in the second quarter of 1952.

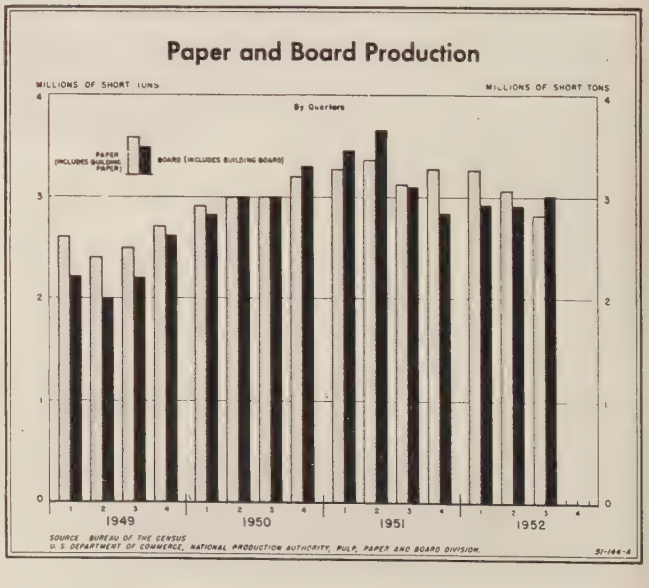
Supplies of wood pulp for the world markets were extremely tight in the latter part of 1950, during 1951 and in the first 2 or 3 months of 1952. By this time, however, many foreign importing countries had been able to establish reasonably good inventory positions while at the same time demands for paper and paperboard showed some weakness. Also, in a number of countries the foreign exchange situation had worsened, thereby causing restrictions on imports. In the U. S.,

Table VIII. Waste Fibrous Materials—Receipts, Consumption, and Inventories

(1000 Short Tons)

Item	1952 3d qtr.[a]	1952 2d qtr.	3d qtr. 1951	First 9 months 1952	First 9 months 1951	Change, %
Receipts, total	2192	2043	2555	6385	8324	−23.3
Wastepaper	1874	1838	2178	5645	7334	−23.0
Straw	145	30	194	225	352	−36.1
Rags	79	83	88	239	316	−24.4
Manila stock	9	9	11	26	36	−27.8
All other[b]	85	83	84	250	286	−12.6
Consumption, total	2237	2151	2427	6609	8306	−20.4
Wastepaper	1927	1866	2089	5733	7163	−20.0
Straw	71	77	90	230	322	−28.6
Rags	79	87	88	244	309	−21.0
Manila stock	8	9	11	26	35	−25.7
All other[b]	152	112	149	376	477	−21.2
Inventories, total[c]	928	974	994	....	....	−6.6
Wastepaper	497	549	577	....	....	−13.9
Straw	170	97	177	....	....	−4.0
Rags	53	53	60	....	....	−11.7
Manila stock	9	9	10	....	....	−10.0
All other[b]	199	266	170	....	....	+17.0

[a] Preliminary. [b] Includes flax, cotton, and other fibers. [c] End-of quarter.
Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.



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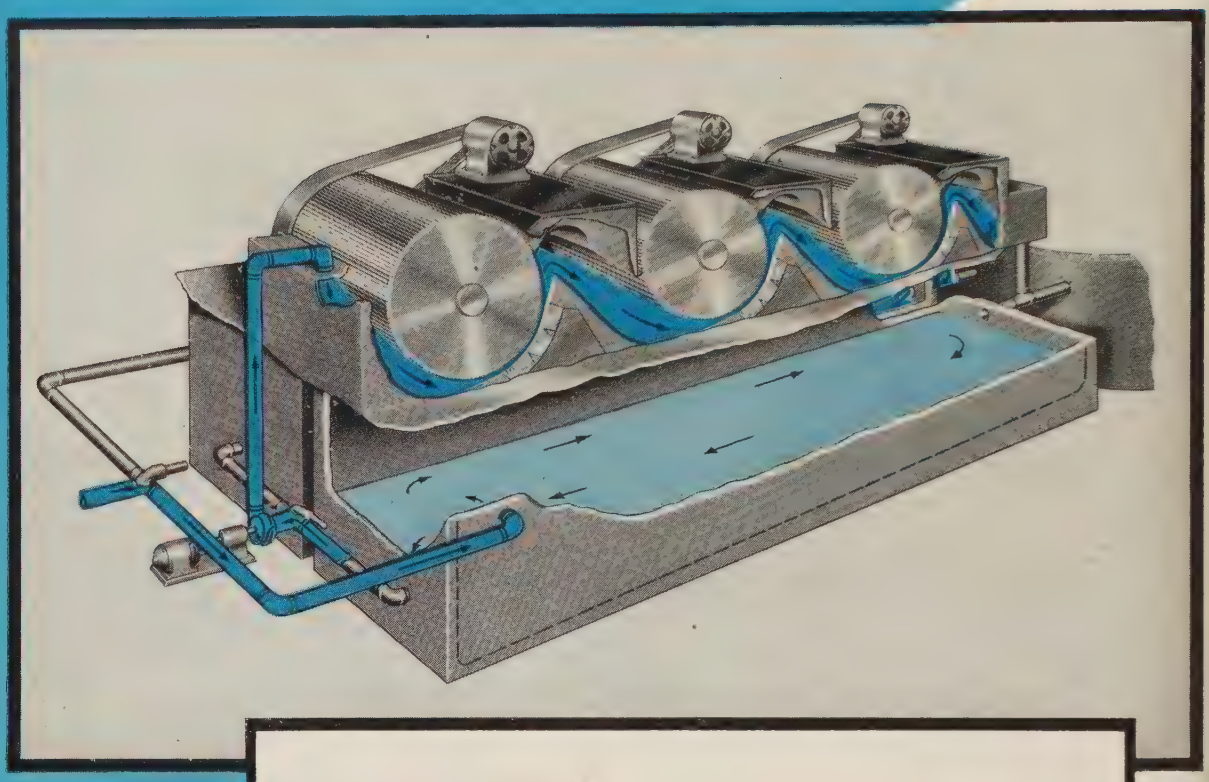
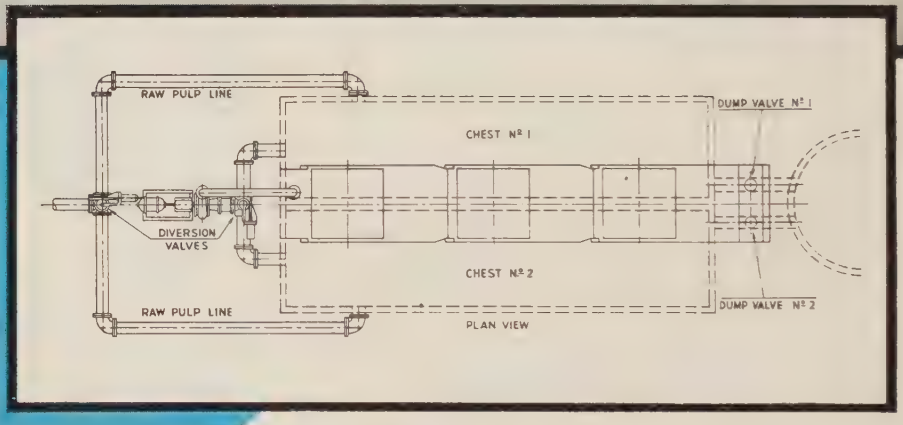
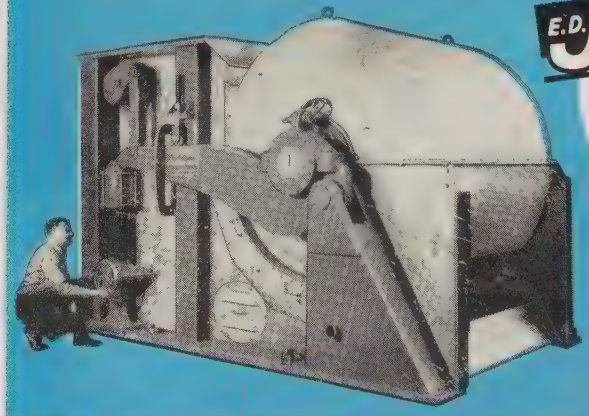




LEGEND

Raw stock is admitted to Chest #1. Diversion valves, controlled by liquid level elements, automatically shut raw stock line, circulate stock from Chest #1 through Multi-Beater and into Chest #2; then again through Multi-Beater back into Chest #1, repeating cycle as required.

On last pass, refined batch is automatically diverted to beaten stock chest at the same time the next batch of raw stock is being admitted to whichever of the two chests is empty, and new cycle begins without pause.



E.D. Jones Pre-Assembled BEATING UNIT

This easy-to-install "packaged" Beating Unit is the heart of the *Continu-flo* system. • Its pre-assembled construction means lower installation cost—no assembly in the mill. • Its proved mechanical design embodies the best features of the famous Jones-Bertrams Patent Beaters — produces better quality stock at lowest cost per unit of refining capacity. • And its integral motor support saves floor space. Available for either tub or multi-beater installation.

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Double-chest Batching System

Here's the answer to the problem of maximum refining quality at minimum refining cost. The only continuous batching system that guarantees full automatic control, Jones *Continu-flo* double-chest batching with Jones Beating Units offers you

Batch-refining quality with the tonnage and economy of continuous operation

Positive uniform treatment of all stock, with readily reproducible results

Greatest refining capacity and lowest operating cost per ton of any type of beating or refining system.

And no shutdowns for dumping! — because once the Microflex Control is set for the required number of passes, operation is continuous and the discharge of refined stock and admission of raw stock is automatic and simultaneous.

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PITTSFIELD, MASS.

OUTSTANDING FEATURES

- More refining capacity — up to twice as much as any similar machine
- Lower operating cost — up to 65% power saving over conventional beaters
- More flexibility of operation
- Fully automatic control
- Proved mechanical design
- Lower installation cost — no assembly of Beating Units at mill
- Less floor space — motor support is an integral part of Beating Unit
- Simpler floor construction — minimum floor loads, no shifting loads
- Positive control of roll pressure and recirculation makes it impossible for untreated stock to pass through unit
- Lower maintenance — completely non-corrosive where exposed to stock

BUILDERS OF QUALITY STOCK PREPARATION MACHINERY

Table IX. Paper and Paperboard Production by Major Types

(1000 Short Tons)

Item	1952 3d qtr.[a]	1952 2d qtr.	3d qtr. 1951	First 9 months 1952	First 9 months 1951	Change, %
All types, total	5845	5974	6223	18,000	19,974	−9.9
Paper, total	2483	2722	2807	8,181	8,637	−5.3
Newsprint	275	283	275	839	824	+1.8
Groundwood (uncoated)	186	207	194	613	577	+6.2
Machine-coated	251	280	270	821	835	−1.7
Book (uncoated)	326	376	383	1,100	1,212	−9.2
Fine, total	284	332	323	989	1,000	−1.1
Rag	30	34	41	102	128	−20.3
Chemical, wood and other	254	298	282	887	872	+1.7
Coarse, total	718	797	878	2,435	2,647	−8.0
Unbleached kraft	517	588	635	1,790	1,892	−5.4
Other	201	209	243	645	755	−14.6
Special industrial	88	102	98	301	311	−3.2
Sanitary	278	269	303	847	921	−8.0
Tissue	52	49	57	153	212	−27.8
Absorbent	25	27	26	83	98	−15.3
Paperboard, total	2631	2565	2740	7,795	9,104	−14.4
Container board	1409	1361	1512	4,154	4,963	−16.3
Folding boxboard	544	522	537	1,592	1,942	−18.0
Setup boxboard	169	156	160	490	551	−11.1
Cardboard	16	18	19	51	63	−19.0
Miscellaneous	493	508	512	1,508	1,585	−4.9
Wet machine board	31	36	31	100	115	−13.0
Construction paper and board	700	651	645	1,924	2,118	−9.2
Construction paper	345	338	317	968	1,110	−12.8
Construction board	355	313	328	956	1,008	−5.2

[a] Preliminary.

Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

the pulp supply situation also eased greatly in the first quarter of 1952 as a result of increased domestic pulp capacity on one hand and a decline on the other hand in demand for end products, especially paperboard. Interest in imports of pulp from overseas declined sharply, partly because of the high price quotations. Northern European pulp exporters started to reduce prices to the U. S. market until by the third quarter they were on about the same level as Canadian and domestic prices. This action was encouraged by their governments by reducing or eliminating export taxes on wood pulp. Nevertheless, Northern European pulp exports to the U. S. and other world markets declined greatly in 1952 and

Table X. Wholesale Price Index Numbers for Selected Sub-Groups and Classes of Wood Pulp, Paper, Paperboard, and Converted Products, and Other Selected Commodity Groups

(Index 1947–49 = 100)

Item	1952 September[a]	1952 August	1952 July	September, 1951	Change, % September, 1952, vs. September, 1951
All commodities other than farm and foods	113.1	113.0	112.5	114.8	−1.5
Pulp, paper and products group	115.7	115.6	115.3	119.4	−3.1
Wood pulp sub-group	109.3	109.3	109.3	114.5	−4.6
Sulphate, Southern, unbleached	96.1	96.1	96.1	127.3	−24.5
Sulphate, bleached	107.9	107.9	107.9	107.9	.....
Sulphite, bleached	112.0	112.0	112.0	112.0	.....
Mechanical	119.7	119.7	119.7	119.7	.....
Soda, bleached	112.9	112.9	112.9	112.9	.....
Wastepaper sub-group	78.5	65.7	44.3	141.9	−44.7
Books and magazines	75.1	75.1	75.1	158.6	−52.6
Folded news	102.6	71.8	41.0	112.0	−8.4
Mixed paper	56.6	56.6	30.9	150.5	−62.4
Corrugated	78.0	62.9	40.2	148.4	−47.4
Paper sub-group	124.0	124.0	123.8	121.5	+2.0
Paper, except newsprint class	122.9	122.9	123.4	122.2	+0.6
Hanging paper	125.1	125.1	125.1	124.5	+0.5
Printing paper	117.0	117.0	117.0	117.0	.....
Book paper	126.1	126.1	126.1	122.4	+3.0
Wood bond	117.9	117.9	117.9	117.3	+0.5
Writing paper	127.1	127.1	127.1	125.1	+1.6
Wrapping paper	124.5	124.5	124.5	121.9	+2.1
Butcher's paper	127.7	127.7	127.7	128.3	−0.5
Waxing paper	120.3	120.3	125.6	123.9	−2.9
Wrapping tissue	115.7	115.7	115.7	137.6	−15.9
Newsprint class	127.5	127.5	124.9	119.4	+6.8
Paperboard sub-group	124.6	124.6	125.4	132.0	−5.6
Container board class	115.6	115.6	115.6	118.2	−2.2
Folding boxboard class	140.0	140.0	141.4	150.0	−6.7
Set-up boxboard class	122.1	122.1	123.6	135.8	−10.1
Converted products sub-group	112.8	113.0	113.2	116.8	−3.4
Building paper and board sub-group	115.8	115.8	115.8	113.4	+2.1
Fuel and power group	106.1	105.8	106.0	106.7	−0.6
Chemicals and allied products group	104.0	104.0	104.2	108.7	−4.3

[a] Preliminary.

Note: For comparable monthly data from January, 1947, through March, 1952, for sub-groups and classes of wood pulp, paper, paperboard, refer to "Pulp, Paper and Board Industry Report" dated June, 1952.

Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from Bureau of Labor Statistics, U. S. Department of Labor.

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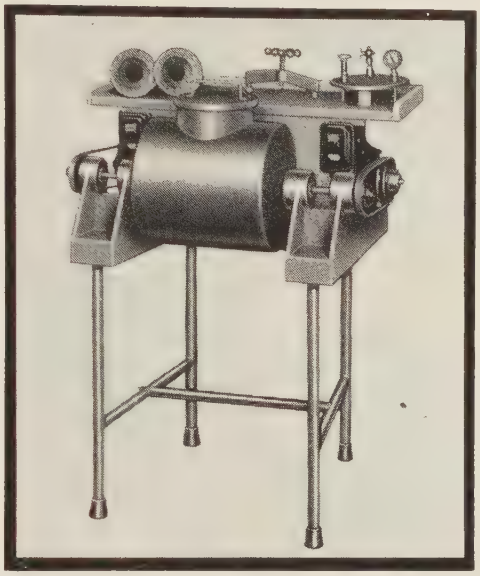
DynoPulpers

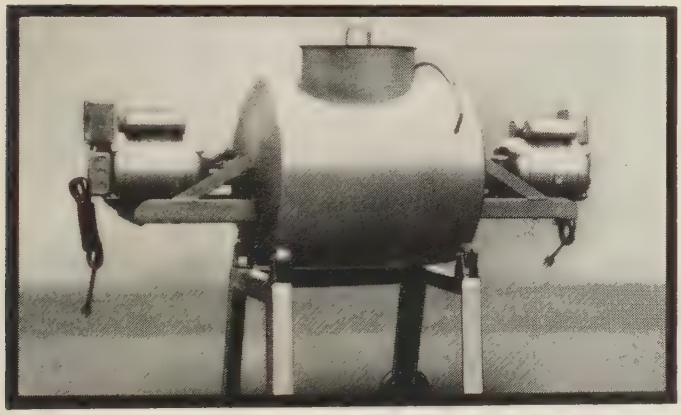
LABORATORY and PILOT MODELS

hem you can:

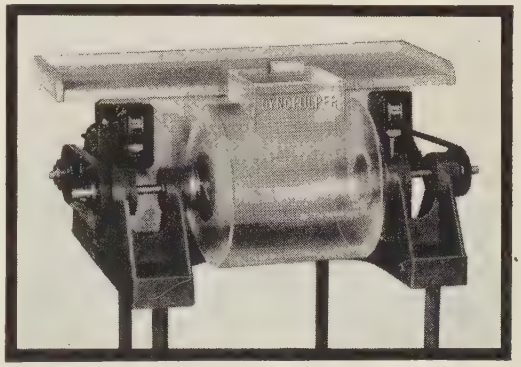
- Evaluate Waste Paper and Pulp
- Recognize Wet Strength
- Determine Shrinkage in Waste Paper
- Establish Dirt Count on Pulp
- Match Colors (two minutes)
- Test Mixtures of Stock



Model 3SP
Laboratory DynoPulper with Stainless Steel Vat. Can be used under pressure. Also available without pressure cover. Capacity 500 grams at 4% consistency.



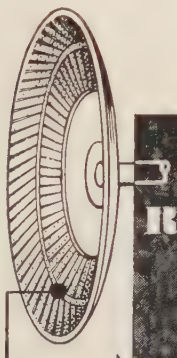
Model 18
Pilot Model DynoPulper. Available in Carbon Steel or Stainless Steel Vat. Capacity 10 lbs. at 4% consistency.



Model 3
Laboratory DynoPulper with Plexiglass Vat. Capacity 500 grams at 4% consistency.

The DynoPeller

the heart of all DynoMachines. s concave face is lined with rough, ard carbide particles. As the Dyno-eller rotates it causes a suction at its enter that pulls the stock toward it. entrifugal force then causes the stock flow rapidly over the rough carbide articles under a gentle hydraulic essure. This effective dynomizing ction completely disintegrates the ock . . . separating each fiber from neighbor while maintaining its iginal length.



These models available on a lease basis ($50.00 per month). Any charges will be deductible from the purchase price of a new lab model or a commercial machine.

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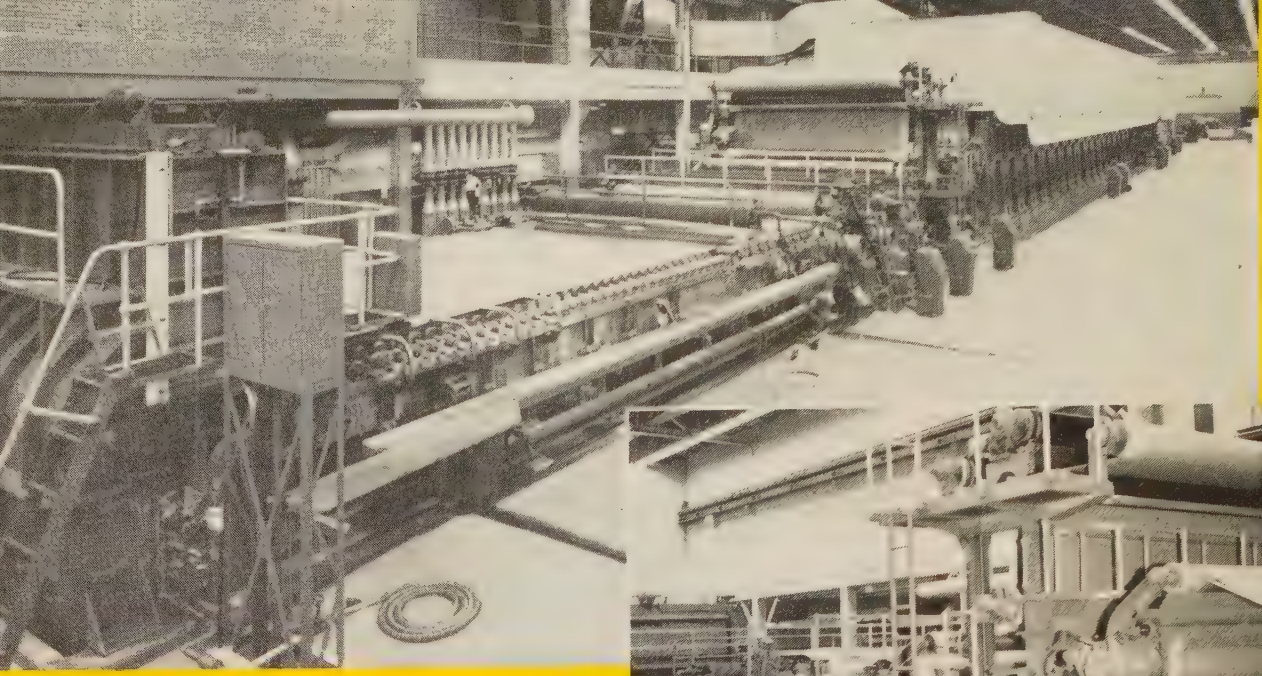
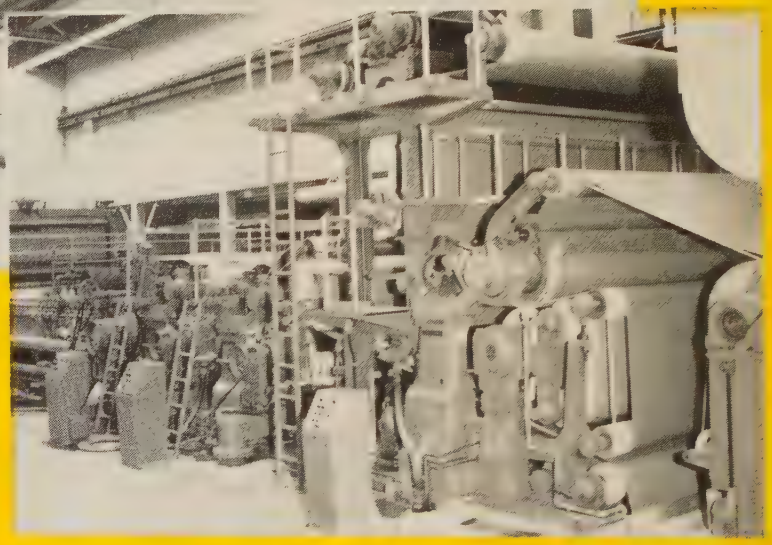
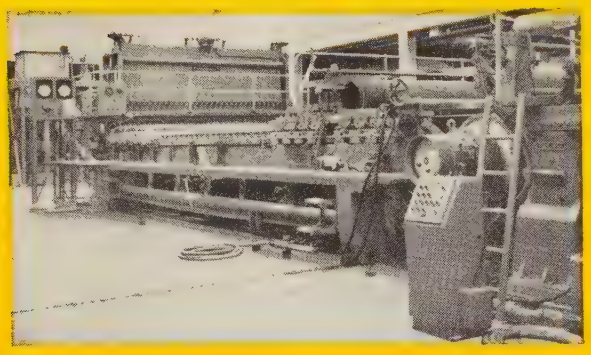


View from Wet End.

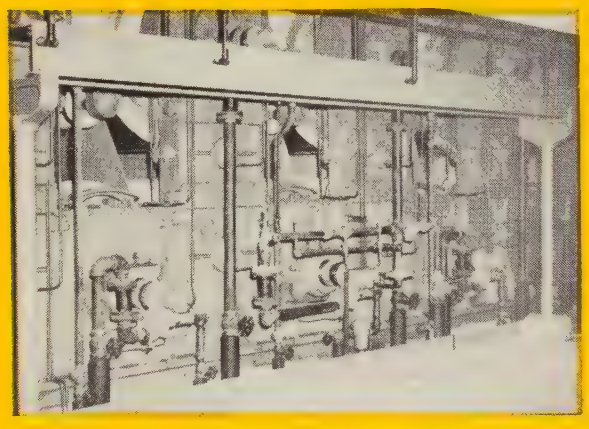


Press Part with two Suction Presses and reversed third press.

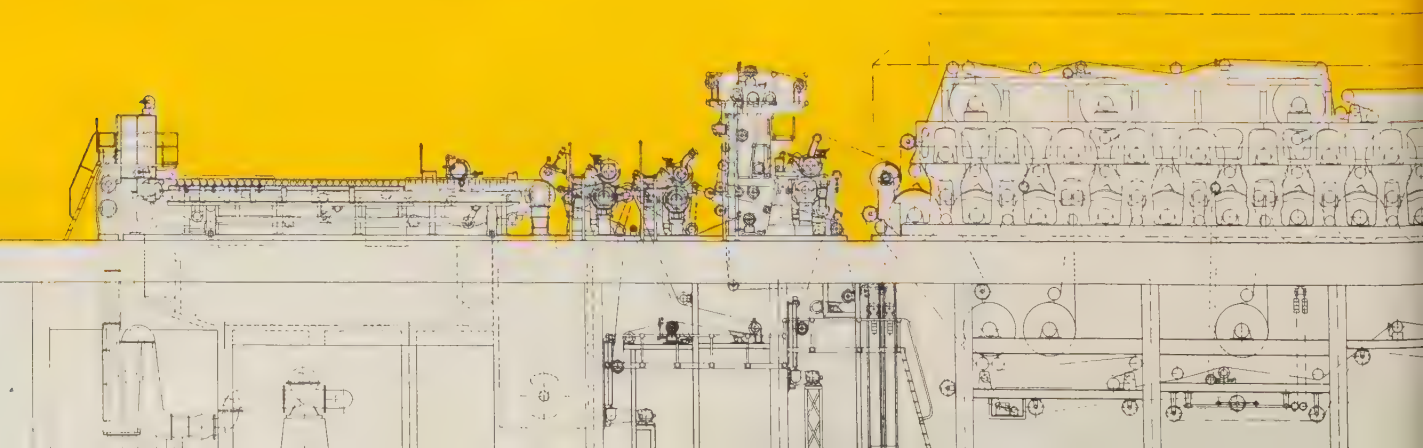


Fourdrinier Wet End.

Dry Part.



Back-side Dryer frames with enclosed gearing.



New Specialty Machine for

NEKOOSA-EDWARDS

new Puseyjones Fourdrinier Machine
r specialty papers began operation at
kkoosa-Edwards Paper Co., Nekoosa,
sconsin, December 18, 1952.

working closely with "Nepco" on the
sign and arrangement of the machine,
seyjones developed a versatile performer
at can be used on many different grades
d weights without limiting production.
e machine is designed for a speed range
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mum turn-over speed of 200 ft. per minute.

The satisfactory performance of the Nepco machine reflects the determination of Puseyjones to "live with" every job until mill management says "well done."

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FEATURES OF 180" PUSEYJONES FOURDRINIER SPECIALTY MACHINE AT NEKOOSA-EDWARDS

Fourdrinier Part: Suitable for wire 180" wide, 85' long, with 26" dia. breast roll, 7½" dia. table rolls and 36" dia. suction couch roll. Wire changing is accomplished with "Rapi-Drape" device.

Press Part: Two main presses each consisting of a 30" dia. suction press roll and 28" dia. top roll with one set of plain press rolls. The third press is a reversed press. A plain bottom press roll may be used in the second press position if desired. A Pneumatic controlled water-marking device operates in connection with the third press.

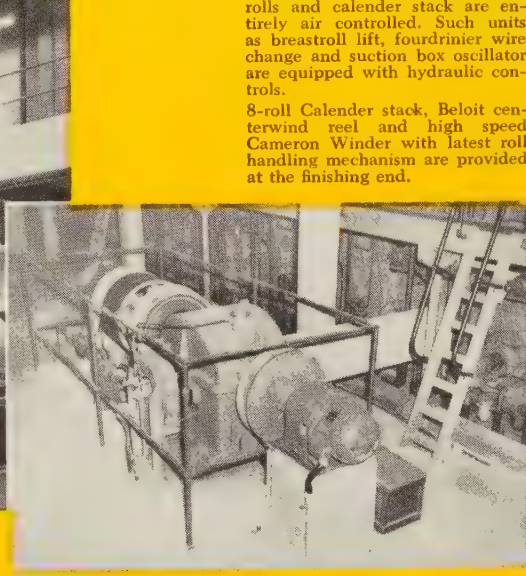
Dry Part: Consists of 36 paper dryers and 12 felt dryers, all 60" diameter, in two separate sections, each section having 18 paper, 4 Feeney and 2 return felt dryers. A third section, consisting of 14 48" paper dryers and 2 felt dryers, follows a Size Press.

Drive: Individual cone drive unit design with enclosed hypoid reduction gearing and a main line shaft in the basement coupled to a Worthington steam turbine of 1000 BHP. Each dryer section drive unit is equipped with an air-actuated brake device for more quickly bringing dryers to stop when desirable.

Controls: All drive and machine controls set in consoles. Such units as lump breaker roll, upper press rolls and calender stack are entirely air controlled. Such units as breastroll lift, fourdrinier wire change and suction box oscillator are equipped with hydraulic controls.

8-roll Calender stack, Beloit centerwind reel and high speed Cameron Winder with latest roll handling mechanism are provided at the finishing end.

View from Dry End.



Drive unit for dryer section with motor-operated starting and inching device, also pneumatic brake.

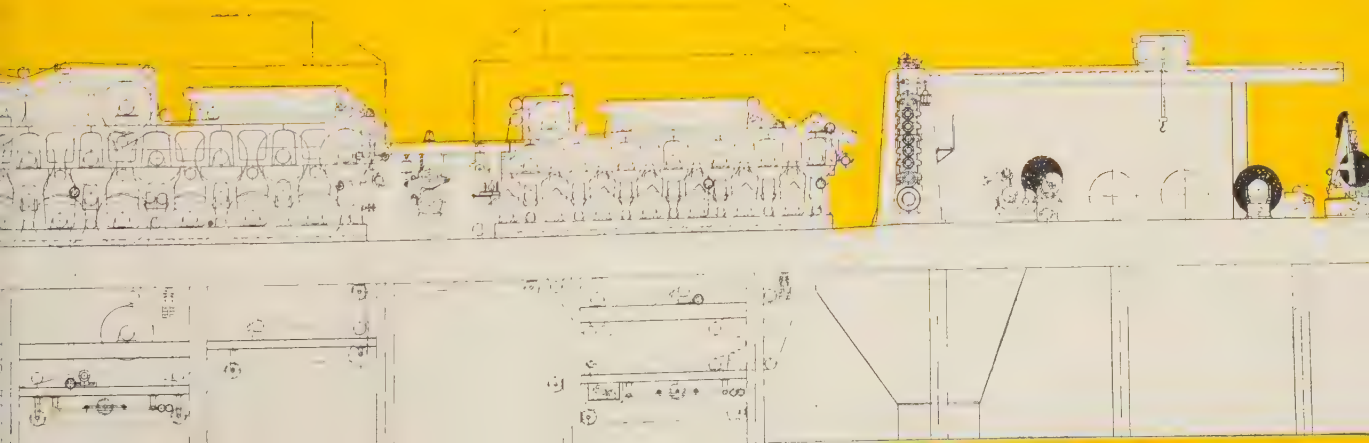


Table XI. Wholesalers Sales and Inventories of Paper and Its Products[a]

(In Millions of Dollars)

Month	Sales				Inventories			
	1952	1951	1950	1949	1952	1951	1950	1949
January	192	228	148	148	254	215	190	209
February	179	198	139	136	258	216	201	213
March	187	217	151	148	269	220	202	207
April	187	199	143	137	271	233	211	206
May	178	212	149	132	274	236	211	209
June	165	203	163	140	269	245	219	210
July	164	179	152	127	272	246	212	207
August	179	209	195	154	268	246	213	202
September	198	183	187	153	261	251	206	194
October	...	218	206	156	...	247	207	196
November	...	194	199	157	...	249	209	190
December	...	164	188	147	...	243	215	185
Monthly average	...	200	168	145	...	237	208	202

[a] Unadjusted for seasonal variations.
Note: These data are revised to 1948 Census of Business data.
Source: Office of Business Economics, U. S. Department of Commerce, based upon Bureau of the Census data.

many mills curtailed production schedules or even shut down for periods of time. Notwithstanding these actions, Northern European (Sweden and Finland) total wood pulp inventories were built up from about 180,000 tons on Sept. 30, 1951, to over 640,000 tons on Sept. 30, 1952. Starting in the fourth quarter, trade reports indicate renewed buyer interest in a number of world markets for Northern European pulp and the volume of North European exports is expected to increase.

Demand for wastepaper improved considerably in the third quarter, with prices firming upward in many grades. Receipts of wastepaper at paper and board mills was up in the third quarter moderately in excess of the second quarter but still considerably lower than the third quarter of 1951. Wastepaper consumption in the third quarter disclosed a similar trend, while inventories at the end of September dropped below those on hand the end of June. The impact of the relatively sudden recovery in demand for paperboard, starting in August, is the chief reason for the better market for wastepaper. In fact, in a few areas there were temporary shortages of wastepaper in the late summer, since some of the sources of supply had disappeared with the low demand and prices of the preceding several months. As will be noted from Table X, prices on folding news and corrugated waste, rose considerably in the third quarter over the second quarter, but were still much below the price levels of 1951.

Much greater interest in wastepaper utilization has developed during the past couple of years. Not alone have dealer associations fostered improvements in trade practice ethics, grading, and baling, but the consuming paper and board mills have also displayed increasing interest in the field. The American Paper and Pulp Association and the National Paperboard Association have sponsored a Waste Paper Utilization Council which was recently organized. Mills consuming wastepaper have encountered more and more difficulty in the last several years in utilizing wastepaper because of the introduction and larger use of new types of inks, coatings, adhesives, resins, etc. in papermaking or use. The dealers did not have the technical facilities to attack this problem and, as a consequence, the cooperation of the consuming mills should prove very constructive to the future of the wastepaper industry.

In the area of pulpwood the industry must attempt to estimate requirements many months in advance, particularly in the northern states where logging is still largely seasonal. Since there were indications in 1951 that demand might continue upwards most mills arranged for a large procurement of pulpwood during the 1951–52 fall and winter logging season. The result was that a large pulpwood stock accumulation took place in 1952 at a time when demand for paper and board were less than in 1951. Many mills faced difficult problems by mid-1952 since even though inventories were too large they felt obligated to continue to buy from regular sources of supply, especially locally cut farmer wood, in order to maintain good will for the future. Inventories of pulpwood at the end of September, 1952, were 20.5% larger than a year previous for the nation as a whole. However, in the northeast region they were up 36%, in the lake states they were up 27%, and on the west coast, up 17%. Only in the southern

Table XII. U. S. Imports of Pulpwood, Wood Pulp, Paper, Board, and Paper Products

(In Short Tons, Except Where Otherwise Indicated)

Item	1952		3d qtr. 1951	First 9 months		Change, %
	3d qtr.	2d qtr.		1952	1951	
Pulpwood (cords of 128 cu. ft.)	593,075	397,714	773,849	1,642,922	1,899,526	−13.5
Wood pulp	421,675	427,792	567,731	1,342,740	1,824,787	−26.4
Waste fibrous materials	18,691	15,858	22,678	57,578	92,154	−37.5
Paper, board, and products, total	1,288,817	1,326,931	1,259,926	3,854,342	3,821,190	+0.9
Paper and board, total	1,282,808	1,321,129	1,257,261	3,838,032	3,810,848	+0.7
Paper, total	1,263,061	1,302,158	1,232,973	3,780,434	3,716,394	+1.7
Newsprint	1,251,273	1,288,802	1,218,403	3,741,024	3,669,573	+1.9
Printing and book paper, uncoated	8,750	11,753	11,661	32,955	34,790	−5.3
Fine paper, total	381	273	270	927	1,116	−16.9
Writing paper	10	16	6	58	64	−9.4
Cover paper	.....	.....	[a]	.....	[a]	....
Bristols	60	41	31	126	244	−48.4
Thin paper	285	198	194	655	636	+3.0
Other fine paper	26	18	39	88	172	−48.8
Wrapping, bag, and converting paper, total	2,070	1,101	2,058	4,400	8,581	−48.7
Greaseproof	108	29	257	248	1,658	−85.0
Vegetable parchment	5	2	1	8	14	−42.9
Kraft wrapping	1,641	950	1,301	3,524	5,240	−32.8
Other wrapping	316	120	499	620	1,669	−62.9
Tissue and crepe paper	17	45	58	117	205	−42.9
Absorbent paper	20	34	23	86	75	+14.7
Building paper	550	150	500	925	2,054	−55.0
Board, total	19,747	18,971	24,288	57,598	94,454	−39.0
Kraft container board	.....	.....	122	.....	967	....
Other container and boxboard	14	5	386	31	1,638	−98.1
Other paperboard	12,344	11,483	17,855	36,370	65,175	−44.2
Fiber insulation board	1,640	1,066	1,086	3,219	2,368	+35.9
Wallboard	5,749	6,417	4,839	17,978	24,306	−26.0
Products	6,009	5,802	2,665	16,310	10,342	+57.7

[a] Less than one-half ton.
Note: Figures subject to revision.
Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

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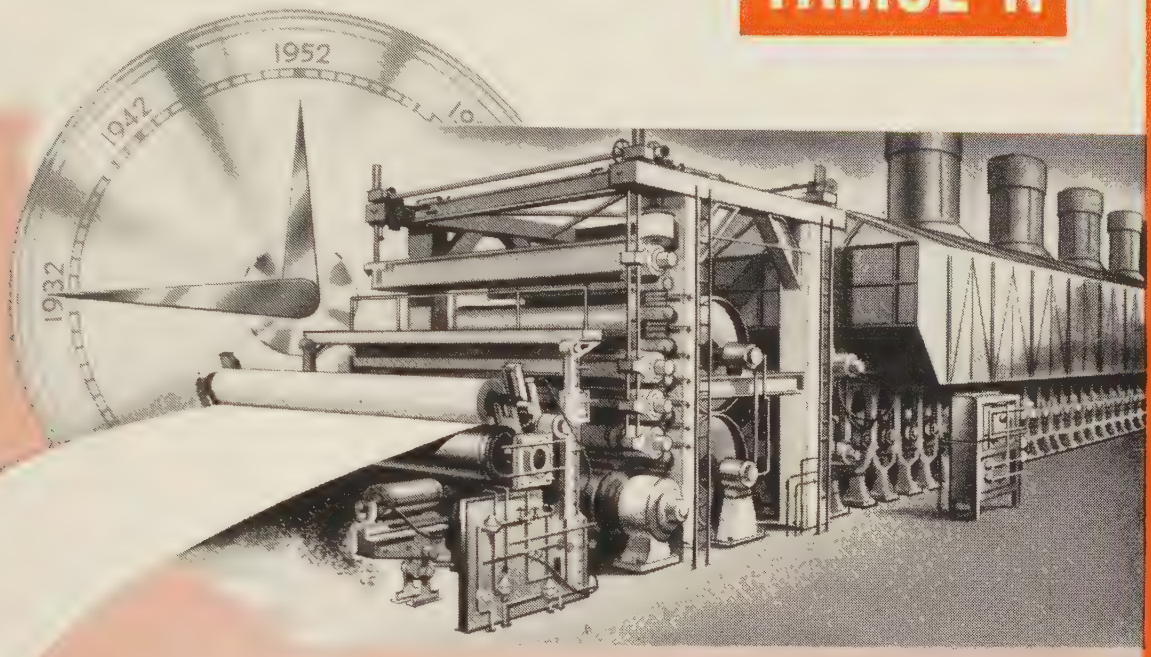

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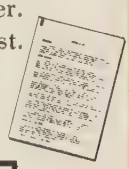

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region where logging is carried on steadily the year around, were inventories lower than in 1951.

In some areas of the south procurement of pulpwood has been handicapped to at least a small degree by the demand for labor for the construction of large governmental projects while at the same time seasonal agricultural activities were drawing on available common labor. Because of these factors, southern pulpwood inventories at the end of September were at a relatively low point, about equal to one week's supply.

On the west coast the extremely dry late summer and fall weather caused some state regulations on forest fire control to be enforced with the result that logging operations were shut down for a period of time. However, the over-all pulpwood supply has continued very adequate and no problems are anticipated on the west coast except the low water levels of the major rivers causing the Defense Electric Power Administration to place restrictions on electric power use starting Oct. 29, 1952, which will cause some limited curtailment in operations at some pulp and paper mills in the Pacific Northwest until further notice.

A steadily increasing percentage of the wood raw material of the west coast pulp mills consists of chips produced from waste materials by lumber and plywood mills. This development is expected to spread to other sections of the country but not to the same degree as is possible on the west coast where lumber and plywood operations are on a larger scale than in other regions.

Total national receipts of pulpwood in the first 9 months of 1952 were 1% less than in the same period of 1951, with considerable variations by regions. In similar comparison, total consumption of pulpwood this year was identical to the 1951 period. However, the south was the only region showing a consumption gain (of 3.7%) while other regions recorded declines of from 1 to 8%.

United States exports of total paper, board, and products in the first 9 months of 1952 showed a gain of 17% over the 1951 period. The most notable increase was in paper (up 60%) and more particularly newsprint (up 103%) uncoated groundwood papers (up 309%), and shipping sack papers (up 199%). Substantial gains were also recorded for coated groundwood, coated and uncoated book papers, cover paper, wrapping and converting papers, and special industrial papers. Exports of paperboard, on the other hand, followed the trend of the domestic market and were considerably less (down 20%) than in 1951 for all grades except liners, which were up 2.6%.

Imports into the U. S. of all types of papers, board, and products were up about 1% in the first three quarters of 1952 over the same period of 1951. However, the most notable increase (tonnage-wise) was in newsprint, being up 72,000 tons or 1.9% above the 1951 level. The only other import items to show gains were thin papers (up 3%), absorbent papers (up 15%), fiber insulation board (up 36%) and converted products (up 58%). All other items showed losses ranging up to 50 to 98% less than in 1951.

Table XIII. U. S. Exports of Pulpwood, Wood Pulp, Paper, Board, and Paper Products

(In Short Tons, Except as Otherwise Indicated)

Item	1952		3d qtr. 1951	First 9 months		Change, %
	3d qtr.	2d qtr.		1952	1951	
Pulpwood (cords of 128 cu. ft.)	6,406	258	4,078	13,719	11,176	+22.8
Wood pulp	36,132	79,319	35,512	176,320	137,321	+28.4
Waste fibrous materials	33,409	39,017	55,368	119,070	152,704	−22.0
Paper, board, and products, etc., total	119,031	169,858	186,798	482,503	411,377	+17.3
Paper and board, total	99,037	146,979	159,018	4 3,184	336,268	+22.9
Paper, total	61,233	102,514	77,214	278,912	174,065	+60.2
Newsprint	18,325	33,918	19,977	91,232	44,821	+103.5
Groundwood paper, uncoated	7,227	11,272	3,781	30,035	7,344	+309.0
Groundwood paper, coated	728	1,777	955	3,728	2,963	+25.8
Book paper, uncoated	2,745	5,437	4,794	15,031	11,212	+34.1
Book paper, coated	2,297	3,763	3,757	11,190	8,152	+37.3
Fine paper:						
Writing[a]	5,962	8,972	7,941	25,812	23,941	+7.8
Bristols[b]	191	346	416	738	925	−20.2
Cigarette	1,525	1,151	2,277	3,679	7,046	−47.8
Cover	217	252	158	616	517	+19.1
Other fine paper	232	270	500	794	1,171	−32.2
Wrapping, bag and converting paper:						
Kraft	11,324	15,706	14,502	41,840	24,687	+69.5
Glassine, greaseproof and vegetable parchment	465	754	1,131	2,265	4,071	−44.4
Other	977	2,346	2,792	6,910	6,849	+0.9
Shipping sack paper	3,647	8,747	5,105	25,734	8,608	+199.0
Special industrial paper	2,560	3,283	2,655	7,583	6,861	+10.5
Sanitary tissue paper stock	253	337	647	796	2,331	−65.9
Tissue paper, except sanitary and fine thin	591	805	1,777	2,870	2,806	+2.3
Absorbent paper	623	659	695	1,907	2,319	−17.8
Building paper	1,344	2,719	3,354	6,152	7,441	−17.3
Board, total	37,804	44,465	81,804	134,272	162,203	−17.2
Paperboard, total	30,661	37,693	74,019	113,413	142,154	−20.2
Container board:						
Liners	17,133	22,434	31,819	64,143	62,540	+2.6
Corrugating material[c]	3,276	1,771	12,848	9,631	17,223	−44.1
Boxboard, bending and nonbending board	4,393	6,374	20,183	17,402	38,250	−54.5
Cardboard	1,729	2,303	3,641	6,864	9,779	−29.8
Other paperboard	4,130	4,811	5,528	15,373	14,362	+7.0
Wet machine board	644	868	774	2,380	3,179	−25.1
Building board, total	6,499	5,904	7,011	18,479	16,870	+9.5
Wallboard, except laminated	2,607	1,722	1,298	6,929	2,655	+161.0
Insulating wallboard, except laminated	3,892	4,182	5,713	11,550	14,215	−18.8
Flexible wood and vegetable fiber insulation	270	394	303	937	878	+6.7
Products	19,724	22,485	27,477	68,382	74,231	−7.9

[a] Includes printing grades other than groundwood or book. [b] Excludes rag index and bogus. [c] Includes other container board.

Note: Figures subject to revision.

Source: Prepared by Pulp, Paper and Paperboard Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

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PAPER AND BOARD PRODUCTION TRENDS BY TYPE OF MILL

For a long time there has been considerable interest in the production trends of paper and board mills wholly integrated, partially integrated, or nonintegrated with wood pulp production facilities.

It was not until World War II, when production, allocation, and limitation controls became necessary under the War Production Board, that the significance of the products of the nonintegrated or partially integrated paper and board mills was fully recognized. Statistics on market pulp as used by mills were compiled in detail for the first time.

and board. These data, while probably not strictly comparable to the market pulp figures of the last several years, do serve to give a comparision.

As would be expected from an over-all knowledge of the industry, the volume of market pulp consumption by paper and board mills has remained relatively constant in the past 22 years, ranging between 2,167,000 and 2,958,000 tons. On the other hand, consumption of own manufactured pulp has increased substantially from 4,122,000 tons in 1929 to 14,991,000 tons in 1951. This trend, of course reflects the fact that capacity increases in the paper and board industry, going

Production Trend by Type of Mill (as Per Cent of Total Production)

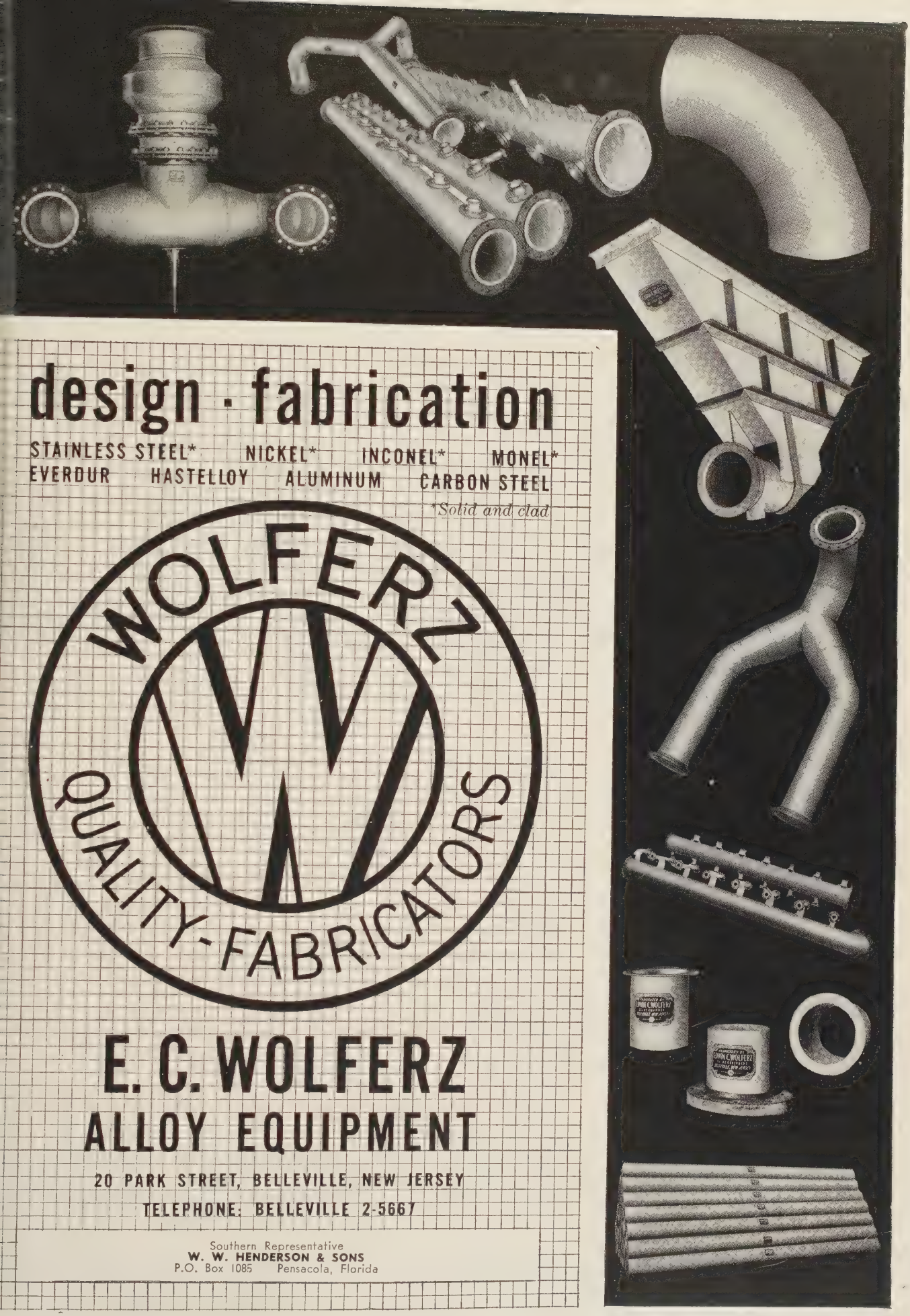
Year	Month	Total all mills — 1000 tons	Total all mills — Per cent	Wholly integrated, %	Partially integrated, %	Nonintegrated, %
	Paper and Board—All Types (Including Building Paper and Boards and Wet-Machine Board)					
1951	July	1,997	100	56.8	13.4	29.8
	August	2,207	100	55.0	14.2	30.8
	September	2,022	100	56.3	14.8	28.9
	October	2,218	100	55.8	15.1	29.1
	November	2,048	100	58.0	14.0	28.0
	December	1,848	100	58.4	14.6	27.0
1952	January	2,105	100	57.7	14.9	27.4
	February	2,006	100	58.0	14.3	27.7
	March	2,072	100	58.7	14.9	26.4
	April	2,014	100	58.5	15.5	26.0
	May	2,011	100	58.3	15.6	26.1
	June	1,951	100	58.3	15.4	26.3
	July	1,762	100	59.1	14.6	26.3
	August	2,052	100	58.4	14.0	27.6
	September	2,024	100	57.1	13.2	29.7
	Paper (Except Building Paper)					
1951	July	874	100	63.1	21.5	15.4
	August	992	100	60.8	21.4	17.8
	September	941	100	60.4	23.0	16.6
	October	1,044	100	59.9	23.5	16.6
	November	990	100	62.4	21.4	16.2
	December	952	100	62.5	21.9	15.6
1952	January	1,028	100	62.9	22.2	14.9
	February	954	100	63.5	22.2	14.3
	March	994	100	64.1	22.9	13.0
	April	940	100	63.4	23.9	12.7
	May	915	100	63.0	23.1	13.9
	June	869	100	63.7	23.2	13.1
	July	766	100	65.0	23.3	11.7
	August	868	100	64.4	22.6	13.0
	September	846	100	61.9	23.6	14.5
	Paperboard (Except Building Board and Wet-Machine Board)					
1951	July	894	100	47.4	8.2	44.4
	August	978	100	46.1	9.6	44.3
	September	864	100	48.6	8.9	42.5
	October	928	100	48.2	8.8	43.0
	November	847	100	50.0	8.3	41.7
	December	733	100	50.5	7.8	41.7
1952	January	880	100	48.7	8.9	42.4
	February	848	100	48.7	8.0	43.3
	March	871	100	48.5	8.6	42.9
	April	855	100	48.3	9.5	42.2
	May	863	100	48.9	11.2	39.9
	June	846	100	49.6	10.6	39.8
	July	775	100	50.4	9.2	40.4
	August	929	100	49.7	9.0	41.3
	September	925	100	49.6	6.9	43.5

Source: Bureau of the Census monthly "Facts for Industry" reports.

It was observed that these smaller nonintegrated or partially integrated mills produced a substantial part of the nation's requirements of many important grades such as sanitary and tissue papers, absorbent papers, special industrial papers, fine papers, and folding and setup boxboard. Since then both the Bureau of the Census and the U. S. Pulp Producers Association, Inc., have compiled wood pulp data on a monthly basis so as to show market pulp production, consumption, and inventories as distinct from total pulp. For certain years, such as 1929 and 1939, the annual Census reports showed pulp production for own use and total consumption in paper

back more than two decades, have been almost entirely in paper and board mills integrated with their own pulp plants. These mills have concentrated for the most part in the "mass production" grades.

Although the volume of market pulp consumption has varied from year to year, depending upon the over-all strength of demand for paper and board, it is noteworthy that the percentage of market pulp used to total pulp consumed by paper and board mills has dropped from 34% in 1929 and 1939 to 21% in 1946, 17% in 1950 and to 15% in 1951. A part of the 1951 decline could be ascribed to the NPA Order M-72 on



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wood pulp which limited consumption of market pulp to 95% of the 1950 rate of use.

Wood Pulp Consumption in Paper and Board Manufacture

Year	Total pulp		Own pulp		Market pulp	
	M short tons	Per cent	M short tons	Per cent	M short tons	Per cent
1929	6,289	100	4,122	66	2167	34
1939	8,650	100	5,692	66	2958	34
1946	12,092	100	9,569	79	2523	21
1947	13,253	100	10,741	81	2512	19
1948	14,375	100	11,788	82	2586	18
1949	13,636	100	11,311	83	2325	17
1950	16,509	100	13,607	83	2902	17
1951	17,731	100	14,991	85	2740	15
1952 (9 mo.)	12,823	100	11,162	87	1661	13

Source: U. S. Bureau of the Census.

In the first 9 months of 1952 market pulp consumption by paper and board mills declined to 13% of total pulp consumed by all paper and board mills.

In terms of volume it would appear that if the rate of consumption of market pulp in paper and board manufacture for the entire year 1952 continued at the level of the first 9 months, only about 2,200,000 tons would be used. This would be the lowest volume in many years and would show a drop of about 700,000 tons less than was consumed in 1950.

The foregoing analysis of the trends of market pulp consumption in paper and board manufacture would indicate that over a period of more than 20 years there has not been any significant growth in the aggregate output of paper and board by nonintegrated mills except as could be accomplished through use of secondary fibers such as waste paper. The figures also suggest but do not necessarily verify that during a year of lowered demand, such as 1949, the nonintegrated mills lose a larger share of the market than the integrated mills. On the other hand, in a year of strong demand, such as 1950, when practically the full existing industry capacity can be sold, the nonintegrated mills are usually able to regain their relative position.

Wood Pulp Consumption in Paperboard in 1949 and 1950 Compared to 1948

Year	Per cent changes from 1948		
	Total pulp	Own pulp	Market pulp
1949	−5	−4	−10
1950	+15	+15	+12

It has been only since July, 1951, that the Census Bureau has compiled and published monthly data on the actual volume production of paper and board by type of mill, namely, wholly integrated, partially integrated, and completely nonintegrated mills.

Assuming that this series can be maintained in the future, it should then be possible to more accurately judge the trend of production by type of operation relative to total production and demand. Nevertheless, the monthly figures from July, 1951, through September, 1952, make possible certain observations which were also apparent from the analysis of the market wood pulp figures.

It will be noted that nonintegrated mills accounted for 29.3% of total paper and board output in the 3 months July through September, 1951, when demand was generally strong, whereas in the 3 months April through June, 1952, when demand had slackened, the percentage had dropped to 26.1. On the other hand, partially integrated mills increased from 14.1 to 15.5%, and wholly integrated mills increased from 56.1 to 58.4% in similar comparison.

A part of the decline in the nonintegrated segment can be ascribed to at least two important mills which became largely integrated with own pulp supply during the past year and as a consequence their production was shifted from the nonintegrated class to the partially or wholly integrated class.

However, it does appear evident from these figures that during the 12-month period July, 1951, through June, 1952, when demand and production were on a downward trend, the nonintegrated segment was not able to maintain as large a share of the total market as when demand was at a higher level. Had monthly data for the first 6 months of 1951 been available, when paperboard production was at a high level and practically all nonintegrated paperboard mills (including some marginal mills) were in operation, it would likely have shown that the nonintegrated mills accounted for even a higher percentage of the total output than in the last half of 1951.

The substantially increased demand for both paper and board, starting in the third quarter of 1952, was immediately reflected in the nonintegrated mills again obtaining a larger share of the total market. In the case of total paper and board the nonintegrated mills' share averaged 27.8% against only 26.1% in the second quarter. It will be noted that in September the nonintegrated share was up to 29.7%, approximately the same position as occupied in the third quarter of 1951. In the case of paper alone the nonintegrated mills were back to 14.5% of the total in September, 1952, against only 12.7% in April, 1952. The nonintegrated mills made even a more notable gain in position in paperboard, returning to 43.5% of the total production in September, 1952, compared to less than 40% in May and June, 1952.

It would be expected that as additional new integrated capacity comes into operation the percentage of nonintegrated output to total production would decline further. The principal question is, therefore, whether or not the nonintegrated segment can hold its relative operating rate in terms of volume output into the future. It perhaps could be anticipated that during the coming decade the nonintegrated mills may face further unfavorable economic factors such a higher costs of raw materials coupled with less efficient manufacturing and distribution processes, as compared with newer integrated operations. With particular regard to market wood pulp, the nonintegrated paper or board mill not alone has to pay for the cost of pulp manufacture (plus a profit), but in addition the cost of drying and shipping which is reported to average up to $25 per ton. Such factors could place nonintegrated mills at a further competitive disadvantage compared with mills integrated with pulp facilities, many of which are also integrated with their own converted products.

The trend toward end product integration has been particularly evident since World War II when numerous pulp, paper, and/or paperboard mills have either built or purchased product converting plants or in some instances the product converter has purchased paper or paperboard mills. This trend has been particularly apparent in the field of containers such as boxes, bags, and sanitary and frozen food packages. In 1947, of the total of 12,309,000 tons of paper and board consumed by paper and board converted products manufacture, 44% was used by companies integrated with their own paper and board mills. Currently the percentage is probably much higher.

There may be, on the other hand, certain factors which will continue to make possible the continued profitable operation of nonintegrated mills. First would be the specialized nature of certain papers which are not suited to the facilities of larger "mass production" mills. These would include "specification" grades, custom-made-to-order in relatively small volume. Special "know-how" and techniques are frequently utilized by many of the smaller mills. The facilities and ability of the nonintegrated mills to make specialties requiring a constantly changing blend of raw materials would, on the other hand, present a headache to many of the large integrated mills.

There may be other economic factors developing in the

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current decade which could be favorable to the nonintegrated mills. Assuming a prevailing strong world-demand for paper and paperboard, a large part of the capacity of the nonintegrated mills should be able to be utilized, provided raw material is available at suitable prices. Additional nonintegrated mills may see fit to establish their own pulp plant facilities to meet at least a part of their wood pulp requirements. It is likely that wood pulp costs will continue to increase relative to the general commodity price levels largely because of mounting cost factors in pulpwood timber procurement. This problem will face the integrated mills directly as well as the nonintegrated mills indirectly.

The trend toward higher pulpwood costs probably will continue as competition increases for available stumpage offered for sale from private lands or from National Forests. Furthermore, more intensive forestry practices, as well as increasing wage rates for woods workers, will add to pulpwood costs even on timber produced on company-owned lands.

Yet, at the same time, a continued growth in paper and paperboard production will mean larger supplies of wastepaper available on the market. Whether or not wastepaper may become an even more significant basic raw material in competition with virgin wood pulp remains to be seen, but it may offer additional competitive advantages to many of the nonintegrated mills in the years ahead. Up to the present time wastepaper has been a potent factor in the preservation of many types of nonintegrated mills.

There is also the wide field of new product and technological developments which may mean a broader range of potential utilization for the facilities of the nonintegrated mills.

Reprinted from the *Pulp, Paper and Board Industry Report* 8, No. 4 (Dec., 1952) issued by the National Production Authority, U. S. Dept. of Commerce, Washington, D. C.

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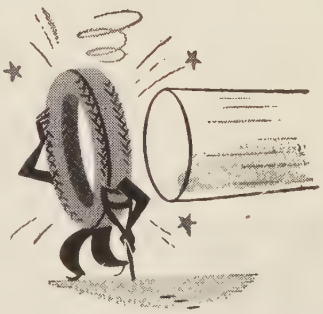
Trying to make packing compensate for excessive shaft or rod wear will shorten packing life materially without alleviating the undesirable condition. Pack correctly to avoid excessive shaft and rod wear. Replace worn shafts and rods as soon as possible to avoid adding the expense of damaged packings to the cost of parts replacement.

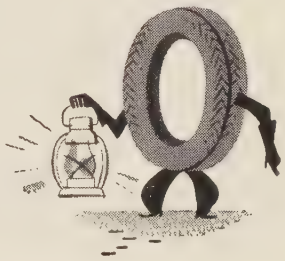


"Bucking" shafts throw me!

Packings are for sealing only. Trying to compensate for shaft misalignment or vibration by overpacking and excessive gland pressure results in scored shafts and ruined packing. Think of a stuffing box as a potential brake assembly that may develop considerable frictional resistance with attendant heat and wear.

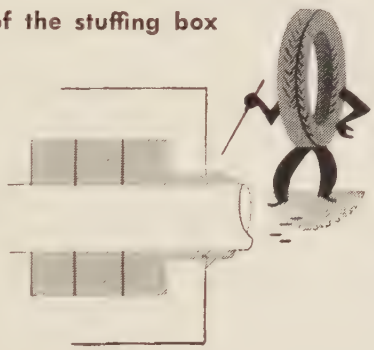
Keep my lantern clear

If the stuffing box is equipped with an oil, grease or water lantern, its purpose is defeated when the lantern ring is omitted or the opening blocked by improperly installed packing or other obstruction. This can deprive the packing of lubrication or cooling and result in premature failure.



Don't let me get out of the stuffing box

If the shaft or rod is badly worn, the packing may be extruded into the system when the gland follower is taken up. Considerable difficulty such as packing getting into valves or scraps or contaminating the fluid handled may result. Rebush the stuffing box or use a junk ring to reduce the clearance.



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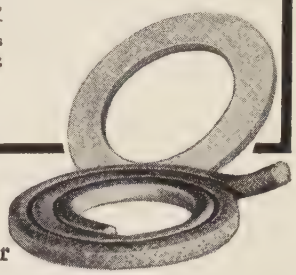

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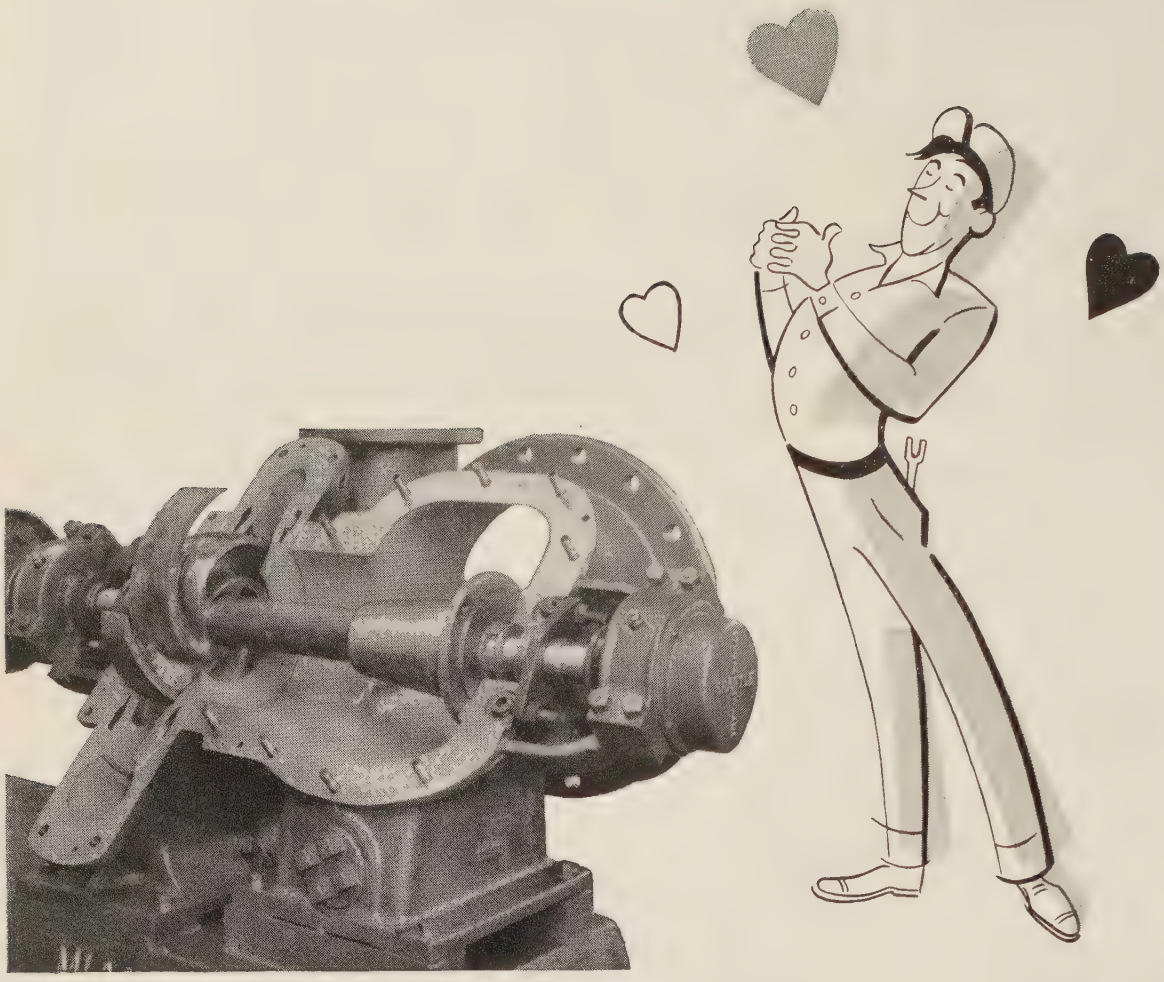

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The Load-Strain Behavior of Wet-Strength Paper

T. S. MORSE, R. T. MASHBURN, and W. H. MARKWOOD, JR.

The Instron tensile tester has been used to measure the energy which wet and dry paper, with and without resin, can absorb: (1) when loaded at a continuous rate to the break point; (2) when cycled three times through load and relaxation cycles to approximately the yield point, then three times near the ultimate breaking load, and finally stressed to failure. Data are presented for laboratory prepared papers made from unbleached kraft pulp at high freeness. One wet-strength resin only was used in the range of 0 to 5%. A special device is described which made it possible to obtain load-strain data while wet test specimens were immersed in water. The dry papers were fatigued by the cycling technique employed, but wet paper containing resin was not. Dry paper containing the resin absorbed more energy than dry paper without resin, but only because the resin increased the ultimate breaking load of the sheet. The resin produced no measurable change in the elongation of the dry paper. Wet paper containing the resin absorbed a great deal more energy than wet paper without resin because both the ultimate breaking stress and the elongation were increased.

WET-STRENGTH papers are well known and widely used in such applications as towels, bags, military maps, and an increasing number of other grades. For purposes of manufacturing control, purchase specifications, and research investigations, the degree of wet strength is commonly measured in terms of either tensile strength and/or bursting strength after soaking the paper in water for a definite period of time. Specifications for wet tensile designate a range of rate of loading. In some cases wet strength is expressed in the units of the test employed, and in other cases as a percentage of the corresponding dry strength test. In some instances the elongation of the paper is specified, measured, and reported. There is, in the literature, a great deal of published information on the influence of the nature of the wet-strength resin used, and the conditions of papermaking on the development of wet strength.

In December, 1944, E. R. Gibbon (*1*) published, in Great Britain, what seems to be the first study of the load-strain behavior of paper where data were collected on such properties as the recovery of paper after the removal of stress. Gibbon's work seems to have inspired further investigation of the rheological properties of paper, and led to the study of "Paper as a Visco-Elastic Body" (*2*) by Steenberg and his associates, and also to work on this subject by others. Data are presented, in the literature, on the load-strain behavior of paper when tested by the alternate application and removal of loads below the breaking load of the paper. Included also in the published reports is information on the effect of the rate of straining and the effect of relaxation time.

T. S. MORSE, Member TAPPI, Sales Supervisor, P.M.C. Department; R. T. MASHBURN, Member TAPPI, Research Supervisor, P.M.C. Department; and W. H. MARKWOOD, JR., Research Supervisor, Evaluation Division, Hercules Powder Co., Wilmington, Del.

The information in the literature deals almost exclusively with the testing of dry paper. Exceptions to this are noted in work by Steenberg where some data are presented on the effect of relative humidity on the load-strain behavior of rag paper (*3*). In addition, a load-strain curve is shown for dry and wet greaseproof paper containing a wet-strength resin at one concentration (*4*). The wet tensile strength of this paper is only 25% of its dry tensile. However, the elongation of the wet paper is approximately four times that for the dry paper; hence, the energy required to rupture a sample is approximately the same whether the paper be wet or dry.

A thorough study of the load-strain behavior of wet-strength papers would require the investigation of the effect of such variables as: (1) the type and amount of wet-strength resin used, (2) the other components of the furnish, (3) the degree and type of stock preparation, and (4) the papermaking conditions employed.

A program of investigation was planned to study the effect of one of these variables; namely, the effect of the amount of a wet-strength resin on the load-strain behavior of one type of paper.

Kymene* 138, a cationic wet-strength resin, was used over the range of 0 to 5% in the preparation of handsheets intended to simulate as closely as possible with the available equipment and techniques, unbleached kraft bag paper. Papermaking conditions and test procedures are described in the experimental section. Briefly, however, the load-strain behavior of the paper when dry and wet was investigated; the paper was tested both when loaded continuously to rupture, and when cycled by alternately loading and unloading the test specimen several times before loading to rupture. All tests were run on the Instron tensile tester.

EXPERIMENTAL

Preparation of the Paper

Laboratory handsheets were selected for this preliminary study since it would have been a formidable task to obtain mill-made paper in which only the resin content was varied over the desired range.

The paper was made on Noble and Wood handsheet equipment. The pulp, an unbleached southern pine kraft, was beaten in a 1.5-lb. Valley beater to a freeness of 800 ml. Schopper-Riegler. The beater was charged with dry pulp and fresh water (pH 7.0) at a consistency of 2.5%. The wet-strength resin was added to the stock at this consistency and followed by alum to pH 4.5. Fresh water, adjusted to pH 4.5 with sulphuric acid, was used to dilute the stock in the proportioner and in the deckle box for the first sheet. Subsequent sheets were prepared using white water (pH 4.5) in the deckle box. After pressing, the web had a con-

* Hercules Powder Co. Trade Mark.

sistency of 33 to 34%. Sheets were dried for 80 seconds on a drum drier at 110°C. The basis weight of the paper was 40 pounds per ream (24 × 36—500).

Kymene 138 resin was used in these studies. Duplicate runs were made at 0, 1/2, 1, 2, and 5% resin solids, based on the moisture-free pulp.

Paper Testing

The Instron tensile tester, described in detail by Hindman and Burr (*5*), was used in all load and strain measurements. This instrument is precision built and is equipped with many accurately controlled and, when desired, automatically operated devices which permit cycling a test specimen through almost any desired predetermined conditions. It is a versatile and sensitive instrument well suited to investigations of the load-strain behavior of paper at rates of loading in the range specified by TAPPI for tensile testing of paper. Studies of the load-strain behavior of paper at higher rates of loading cannot be made on this instrument because of the limitations of the recording mechanism. The installation of a recording mechanism having a faster response would be required for studies at higher rates of loading.

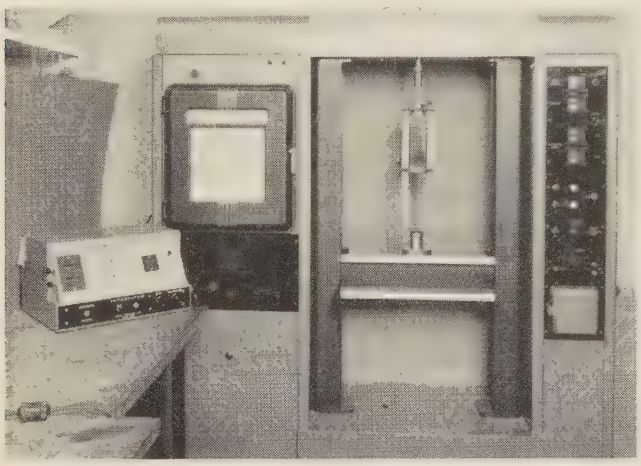

Fig. 1. The Instron tensile tester showing the integrator and immersion device with the tank in the closed position

A photograph of the instrument is shown in Fig. 1. The attachment shown on the lower jaw of the instrument was used for the testing of wet (immersed) paper and this is described later. The lower jaw is movable and its rate and direction of travel can be controlled with considerable accuracy. When the jaw moves downward, the load applied to the test specimen is transmitted to the recording mechanism through a strain gage connected to the upper (fixed) jaw. The rate of travel of the lower jaw is actually the rate of extension of the specimen. This is in contrast to the pendulum-type tester, where both jaws of the tester are free to move and, hence, the crosshead speed does not indicate directly the rate of straining.

The Instron integrator is also shown in Fig. 1. The integrator is interconnected with the load indicator of the recording mechanism and the drive mechanism of the movable jaw of the tester. It integrates a function of $L(dt)$ where L is the deflection of the load indicator and t is time. By using factors to convert L to load and t to jaw travel distance (or elongation), the integrator count can be converted directly to work. There are two counters on the integrator; one functions when work is being absorbed by a specimen and one for work recovery. The direction of motion of the crosshead selects the proper counter by means of electronically controlled clutch systems. Through the use of the integrator it is possible to compute the work input and work recovery without the use of a planimeter. There are certain necessary corrections which must be applied in using the integrator, but this is, relatively, easily accomplished through the use of appropriate correction curves.

Figure 2 shows a close-up of the immersion device used for the wet paper tests. This device was needed because preliminary tests without the immersion device gave higher and more variable results than were obtained by testing the paper when immersed. Apparently, some drying of the samples occurred during wet testing which caused high and variable results. The use of the immersion device eliminated this variable. To ensure complete wetting, all wet samples were presoaked for 24 hours in distilled water before immersion testing.

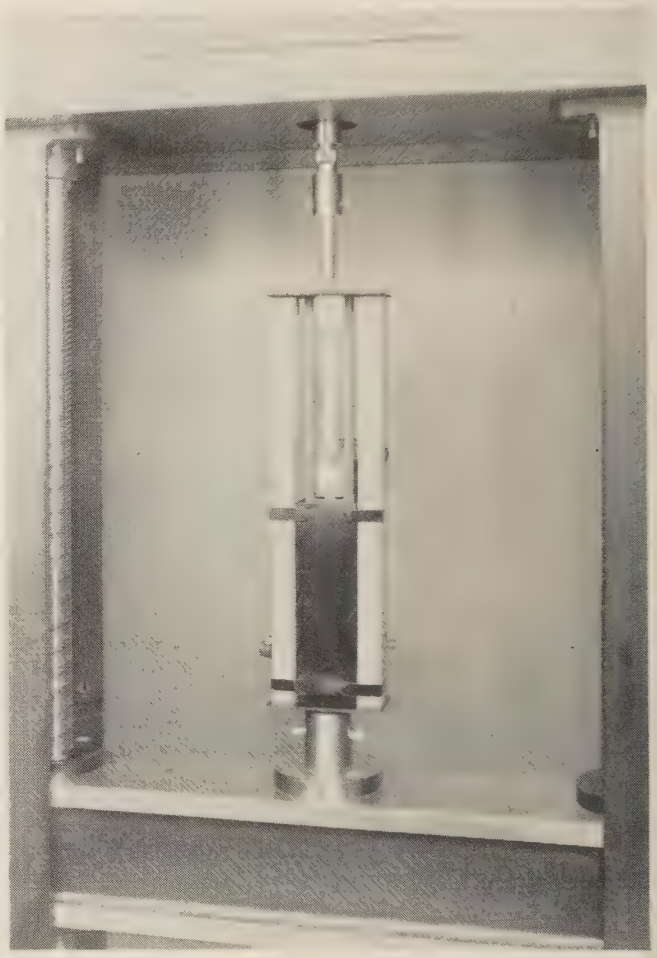

Fig. 2. The immersion device showing the tank in the open position

Five specimens from each sample were tested and all results reported were averages based on these tests. Both dry and wet (immersed) paper samples were subjected to all tests.

All test specimens were cut to $^1/_2$-inch width using he Thwing-Albert cutter. The length was such that ll tests could be run at a jaw separation of 5 inches.

All paper was cured for 1 hour at 105°C. to insure omplete and uniform curing of the resin. It was then onditioned for 48 hours at standard TAPPI testing onditions, 23°C. and 50% R. H. before testing.

The lower end of the wet test specimen is clamped to he immersion device, which in turn is fixed to the lower aw of the tensile tester. The cup containing water is hen slipped upward to keep the sample immersed uring testing. Dry test specimens are merely clamped the jaws.

A crosshead speed of 1 inch per minute was used roughout these studies. This was the rate of load- g and unloading. A chart speed of 10 inches per inute gave a satisfactory magnification of strain.

Two types of test conditions were employed. The rst involved continuously loading the specimen to upture. The second required cycling the specimen y alternately loading and unloading it through six cles; then loading to rupture.

Typical load-strain curves are shown in Fig. 3, and

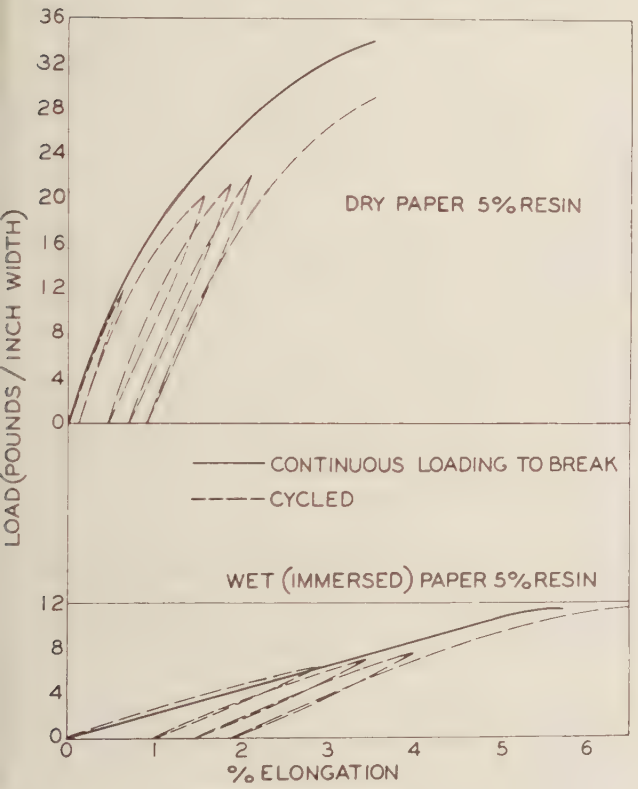

Fig. 3. Typical load-strain curves for dry and wet paper showing the effects of cycling

he testing conditions can probably best be explained y referring to these curves. The procedure of loading ontinuously to rupture was straightforward and pro- luced load-strain curves as shown. The approximate ield loads were determined from these curves. In rder to control the cycling procedure for the first hree cycles, the instrument was set so that the cross- ead would reverse automatically at this predetermined ield load and return to its original starting position. t would then reverse automatically and begin a new cycle. Since paper is not perfectly elastic even at small loads, the procedure does result in some small permanent deformation. However, it would be difficult to show all three curves for these cycles because of the small displacement in the curve for each succeeding cycle.

The fourth, fifth, and sixth cycles were performed by loading the specimen to a point nearer the ultimate, then unloading it. In these cases an equal amount of work was put into the specimen during each cycle.

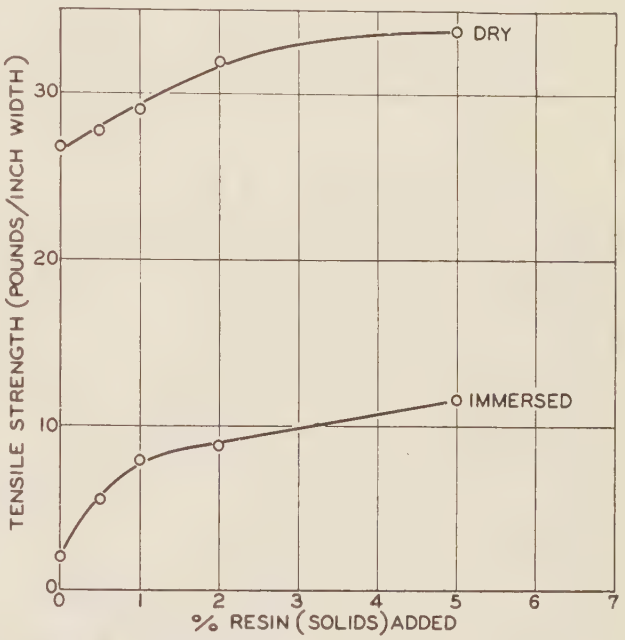

Fig. 4. Tensile strength—effect of resin added

To do this the instrument was operated so that the movable crosshead was reversed manually at its lowest point of travel at a definite integrator count. This integrator count is, of course, a measure of the amount of work input. When the movable crosshead had returned to its original uppermost position its direction of movement was reversed automatically, starting a new cycle. The final cycles thus obtained are again evident from the curves in Fig. 3. After the sixth cycle was complete the load was allowed to continue to build up to rupture.

All elongation, load, and work data, which have been plotted, were obtained directly from these load-strain curves or calculated from the integrator count and a knowledge of the instrument settings.

DISCUSSION OF THE DATA

Figure 4 shows the effect of the amount of resin added on the wet and dry tensile strengths. For paper made under this particular set of conditions, the slope of the dry-strength curve does not change sharply until at about 2% resin added, whereas the wet strength increases rapidly up to 1% resin added, then more slowly but continuously over the remaining part of the range covered.

Figure 3 shows typical load-strain curves obtained both by the cycling procedure employed and by loading continuously to rupture. Curves are shown for wet and dry paper containing 5% resin; they illustrate the type

of data obtained through the use of the technique described. The first three cycles cannot be illustrated clearly in these curves since the "permanent" load resulting from these cycles is so small and the peak loads for these cycles are so similar. The effect of the next three cycles can, however, be readily observed. All of the load-strain information obtained by this technique will not be reported, but specific data on elongation and energy thus obtained are included here.

Figure 3 may also be used to illustrate the differences

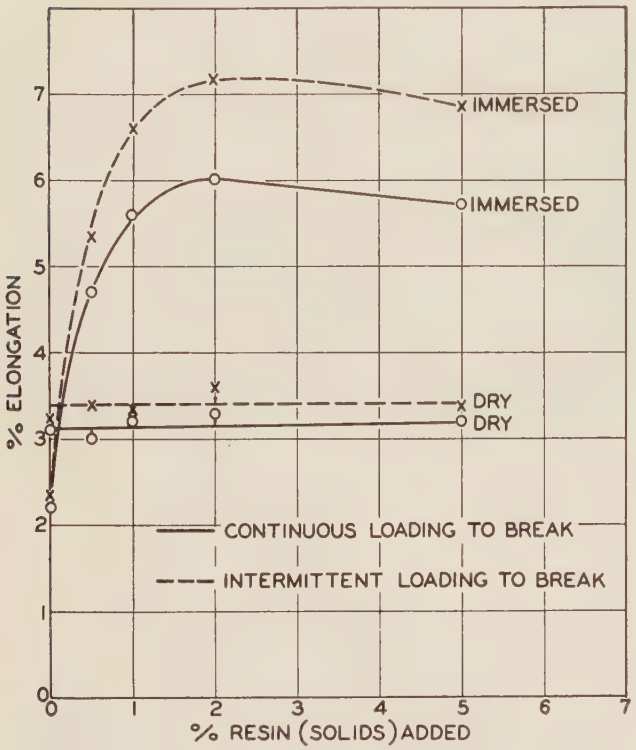

Fig. 5. Total elongation—effect of resin added

between the actual energy absorbed by the paper before rupturing as compared with the apparent energy input which would have been measured by a pendulum-type tensile tester. Pendulum-type instruments normally measure only the ultimate load and elongation. The apparent energy input thus determined would be represented by the area under a straight line joining the ultimate load point and the origin. The area under the Instron load-strain curve is a measure of the actual energy input. The differences between apparent and actual energy input are appreciable in the case of dry paper, but reasonably small in the case of wet paper since the latter load-strain curves are almost straight lines.

Referring again to Fig. 3, the higher loads applied, and the consequent lower elongations attained for successive cycles with equal work input (the fourth, fifth, and sixth cycles) suggest a type of work hardening.

Figure 5 shows the effect of the amount of resin added on the wet and dry elongation of the paper for both conditions of loading. These elongation values are the total elongations as indicated in Fig. 3. In the case of samples which have been cycled, the elongation is the sum of the elongations caused by the six cycles and the final loading to rupture. The total elongation of wet paper increases with the addition of resin up to 2% (dry basis) added. At 2% resin added there seems to be a maximum point in both curves, with elongation becoming slightly less as the resin content is increased up to 5% added. This decrease in elongation is rather small between 2 and 5%, and more data would be necessary to establish the exact course of these curves. The data are consistent, however, in that the curves for cycling and continuous loading are parallel over this range. Cycling before breaking resulted in a sizable increase in the elongation of all wet papers where more than about $^1/_2$% resin was added.

Cycling the dry papers resulted in a slight increase in the elongations. The addition of resin in any amount over the range studied had no significant influence on the elongation of the dry paper.

Figure 6 shows the relationship between work or energy input and per cent resin added. The work values for paper which had been cycled are those for the final loading to rupture. By referring to Fig. 3, it will be noted that this work is represented by the area under the final load-strain curve after the samples had been subjected to the six previous cycles. The work values shown in Fig. 6 do not, therefore, indicate

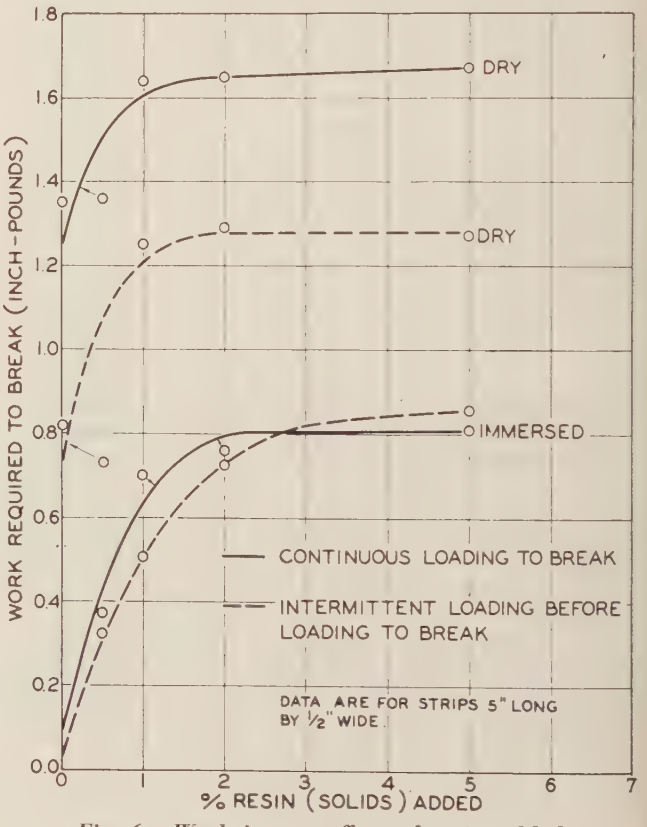

Fig. 6. Work input—effect of resin added

the total amount of energy which had been absorbed by the paper, but rather that which it was capable of absorbing after being previously loaded and permanently strained.

Cycling decreased the energy which the dry paper could absorb since the curve for the dry cycled paper is considerably below that for dry paper stressed continuously to failure.

The wet paper reacted differently, however. Its ability to absorb energy is changed only slightly by

cling. Additional data would again be necessary to tablish whether or not the curves actually do cross shown. The work data obtained on wet paper con- ining 2% or more resin when either cycled or uncycled monstrate that the paper can absorb: (1) as much or ore energy than can be put into dry paper containing resin, but which has been cycled; (2) approximately % as much energy as can dry paper with no resin d uncycled; and (3) 50% as much energy as can dry per containing 2% or more resin and uncycled.

SUMMARY AND CONCLUSIONS

Paper handsheets were prepared at 40 pounds basis ight (24 × 36—500) from high freeness unbleached ft pulp containing 0 to 5% Kymene 138, a cationic t-strength resin. The load-strain behavior of these pers has been studied using an Instron tensile tester der two conditions of loading and with both wet and specimens. The conditions of loading involved: continuously loading to rupture; (2) cycling through preliminary cycles of loading and relaxation, then ressing to rupture.

An interpretation of the data collected leads to the llowing conclusions:

1. Wet and dry tensile strengths of the paper in- ase with increasing resin additions.
2. Dry elongation is not affected by the addition the resin under either condition of loading.
3. Dry elongation is increased only slightly by cy- ing.
4. Wet elongation is increased with increasing resin additions up to about 2% added.
5. Wet elongation is increased substantially by cycling.
6. Work hardening, of a type, has been demonstrated. This is common to other types of papers.
7. Wet and dry work input (when finally loaded to rupture) increases with increasing resin content up to 2% added.
8. The dry papers fatigue on cycling.
9. Wet papers containing resin do not fatigue on cycling.

A more complete knowledge of the load-strain behavior of wet-strength paper may lead to a better understanding of the requirements and performance of these products.

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The Use of Asphalt Emulsions in the Manufacture of Insulating Board Products

J. J. PEROT

his paper presents a brief history of emulsified asphalt zes together with the evolution of insulating board from substitute product to its present status of a structural uilding material. Techniques for the introduction of phalt emulsions into insulating board furnishes and the nefits derived therefrom are discussed briefly.

Asphalt dispersions have been used for many ars for internal sizing of paperboard. Introduced out 1920, they found application in boards where high sistance to water and high strength were required. ypical uses were the sizing of automotive panel board d the inner plies or "filler" of boxboard, felts, sheathg, etc.

There are now available a number of emulsions of cellent stability and uniformly fine particle size made m asphalts of various melt points and hardnesses.

The use of modern asphalt emulsions received a great petus from the demands of the armed forces during orld War II for shipping containers which would withand abuses during shipping, handling, and storage under conditions not encountered during peacetime applications. These demands led to the development of the V boards which were sized with asphalt emulsions. These developments and the functions of asphalt emulsion sizes have been described earlier (*1–4*). It was found that the water resistance of V boards sized with asphalt increased with increasing addition of asphalt beyond the limits reached by other sizing materials without creating operating problems such as filling of the felts and wires and excessive foaming. It was also found that the strength of V board sized with asphalt emulsion was higher than that of boards made from the same furnish and sized to the same degree of water resistance with other sizing materials (*1*). Higher retention of strength after water immersion was also noted on the products sized with asphalt emulsions. Asphalt usage on the V boards ranged from 4 to 8% asphalt solids based on the weight of the fiber.

From the end of World War II until the Korean War the volume of weatherproof boxes manufactured declined sharply and domestic shipping containers were made from boards of lower strength and waterproofness.

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The use of asphalt emulsions continued and expanded, however, although the industry had found that 1 to 2% asphalt and solids based on fiber weight provide adequate sizing for most peacetime products. With the Korean War and the present defense activity, there has been a heavy demand for weatherproof boxes sized with asphalt emulsion.

The insulating board industry, which came into being about the turn of the century, has shown remarkable growth until now more than a dozen companies manufacture a wide variety of products.

The original insulating boards were designed primarily for interior use where requirements of water resistance are a secondary consideration. The development of interior insulating boards has continued until at present a wide variety of decorative products are finding increasing acceptance in modern buildings. Since asphalt emulsions impart a rich, brown color to insulating board stocks, they are not normally used on interior decorative boards.

Insulating boards have also moved to the exterior of buildings. The introduction of insulating siding in the 1930's resulted in the creation of a new industry which today consumes large amounts of insulating boards. Insulating sheathing is another example of an exterior use of an insulating board product. This material is becoming increasingly popular since it serves as both an insulating and a structural material and its ease of application offers savings in labor which cannot be had with conventional wood sheathing.

Both insulating siding and sheathing require boards of high strength and water resistance. The siding receives a partial saturation with asphalt during conversion and the weathering surface receives a surface coating of asphalt in which mineral granules are embedded. During installation, it is sometimes necessary to cut the insulating siding panels to fit around doors, windows, and other openings thus exposing the baseboard. Adequate sizing of the baseboard, therefore, is important in preventing water uptake at these points.

In the case of insulating sheathing, inclement weather and improper on-the-job storage often expose this product to liquid water for extended periods of time.

The use of asphalt emulsions for sizing insulating sheathing and siding base offers many of the same advantages in water resistance, machine operation, and product quality noted above in the manufacture of V boards.

A number of manufacturers incorporate pulverized asphalt into the fiber furnish of exterior insulating board products. Asphalt emulsions may be used with pulverized asphalt to improve water resistance or, used alone, offer a convenient means of introducing asphalt into the furnish without requiring special pulverizing equipment and without creating any of the operating problems, such as fouling of the drier rolls which are sometimes encountered with powdered asphalt.

The introduction of asphalt emulsions into the furnish of insulating board stocks presents no particular problems. Certain precautions should be observed to insure maximum efficiency. The emulsions should be added prior to the addition of alum and adequate agitation should be provided to insure complete mixing. Since the solids content of the emulsions is closely controlled during their manufacture, metering devices can be used to insure uniform addition of the sizing material. Alum should be added immediately prior to the time the stock reaches the headbox. Agitation should be kept to a minimum after the emulsions are flocculated. The pH of the stock after the addition of alum should be between 4.5 and 5.5 to obtain maximum retention and sizing efficiency.

A number of companies are at present using asphalt emulsions successfully in insulating boards formed on both cylinder and fourdrinier-type machines. The usage ranges between 2 and 5% asphalt solids based on fiber weight and depends upon type of fiber, other furnish components, and the water absorption standards set by the manufacturer.

Table I. Physical Properties[a] of 1/2-In. Insulating Board Sized with Asphalt Emulsion, Asphalt and Wax, and Asphalt and Rosin

Run	No. A	No. B	No. C	Fed. Spec.[c] LLL-F-321b
Sizing materials[b]				
Asphalt emulsion, %	4	4	5	. .
Dry rosin size, %	0	1	0	. . .
Wax emulsion, %	1	0	0	. .
Board properties				
Caliper, 0.001 in.	514	522	527	0.5 ± 1/16
Weight, lb./1000 sq. ft.	704	708	721	. . .
Density, lb./cu. ft.	16.4	16.3	16.4	. . .
Tensile, lb./sq. in.				
With machine	182	200	210	150 min.
Cross machine	201	201	215	150 min.
Transverse strength, lb.				
With machine	14.6	16.3	17.4	14 min.
Cross machine	14.7	14.7	17.0	14 min.
Water absorption, 2 hr., % by volume	4.65	4.44	4.14	.

[a] Tested according to methods described in Federal Specification LLL-F-321b.
[b] Calculated as sizing solids based on dry fiber weight.
[c] Class E—sheathing.

The results of a series of three experimental plant runs using asphalt emulsion alone and in combination with wax and rosin sizes are shown in Table I. Sizing materials were added to the stock separately and agitated thoroughly prior to the agitation of alum. The product was 1/2-in. insulating board. The data shown are averages of tests made periodically during each of the three runs. The requirements of Federal Specification LLL-F-321b for class E sheathing board are included for comparison.

These results show that the board containing only asphalt emulsion has somewhat higher tensile and transverse strengths and slightly lower water absorptions.

This series of runs also shows that asphalt emulsions can be successfully used in conjunction with both wax and rosin sizes.

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The Chemical Nature of Cedar Barks

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his study indicated a significant similarity between the tractives from the barks of incense, Port Orford, and estern red cedars. Extractive content, distribution, and hysical properties corresponded closely. The extractive elds ranged from approximately 15 to 29% for all three ecies, depending on the section of the tree from which e bark sample was removed. On the whole, samples m the tops of the cedars investigated contained more tractable material than the bottom samples. The elds and distribution of bark phlobatannin from the ree species were similar. The yields ranged from 4 to %, which is lower than that required for economical mmercial extraction. Bark samples from the tops of e cedars gave the greatest amount of tannin, bottom mples the least. The chemical nature of the hexane, enzene, and hot water extracts from incense cedar bark as determined. The hexane solubles consisted of small mounts of volatile oil, resin acids, phytosterol, crystalline tty acid, and wax. Larger quantities of free and combined fatty acids showing unsaturated properties also were olated. The benzene solubles contained over 72% resin cids, which were present in both the free and combined rms. This information is significant in that previous vestigations do not show them to be present in the combined form. The benzene extract also contained signifiant amounts of unsaturated free and combined fatty cids. The presence of oleic and linoleic acids was not dicated. A water-soluble carbohydrate material conained mannan, galactan, glucosan, pentosan, and uronic nhydride. An alcohol-insoluble tannin substance also ccurred with this carbohydrate material. Holocellulose, mprising 36% of the bark, was prepared. Appreciable egradation of this holocellulose resulted if attempts ere made to lower its lignin content below 6%.

CONSIDERABLE importance is being attached to he utilization of the large volume of bark residues from mbering and pulpwood operations. The barks of me species, notably Douglas-fir, redwood, and some ines, have been shown to contain valuable products. Iore complete utilization of such barks is now made easible through the determination of their chemical mposition.

A search of the literature revealed that little informaon about the components of the bark of the cedars as been published. The present article describes the sults of an investigation of the barks of three western edars: incense cedar, *Libocedrus decurrens*, Torr.; ort Orford cedar, *Chamaecyparis lawsoniana*, A. Murray; and western red cedar, *Thuja plicata*, D. Don. he work was undertaken with the hope that a characrization of the chemical components of cedar barks ight lead to the future development and use of a eglected, natural raw material.

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INCENSE CEDAR BARK

Collection and Preparation of Samples

The samples used for this investigation were collected in May, 1950, from trees felled during the same week in the Umpqua National Forest, located in Oregon. Table I is a summary of the collection data. The shreddy, deeply furrowed, cinnamon-colored bark samples from the various trees were sorted into three age groups that were labeled I, II, and III. In each age group, there were samples taken from the bottom, middle, and top of each tree. For this species then, there were nine composite samples.

Each sample was ground in a Rietz disintegrator to pass a 20-mesh screen. The ground bark was air dried at room temperature, placed in sealed glass jars for storage, and each jar labeled with age group and section of the tree.

Distribution of Extractives

All three bark samples (bottom, middle, and top) from each age group were extracted with the following solvents, in the order given: hexane (petroleum fraction, b.p. 60–70°C.), benzene, diethyl ether, hot water, and 95% ethanol. The samples were first extracted with hexane to remove oils, fats, waxes, and resins. Benzene removed the waxes and resins not previously taken out by hexane. These treatments were followed by extraction with diethyl ether which normally removes flavones or like crystalline coloring matters (*8*). Hot water removed the tannin and soluble carbohydrates. The final extraction with 95% ethanol showed the amount of phlobaphenes present.

With the exception of the hot-water treatment, all extractions were carried out with 25 to 35-gram samples enclosed in cotton cloth bags in glass Soxhlet extractors. The samples were extracted continuously for 8 hr. by which time the current extract was colorless and contained a negligible amount of soluble solids. The extract was filtered into a tared glass dish, evaporated on a steam bath, and dried in an oven at 105°C. for 1 hr. The amount of dry residue was determined by cooling the dish in a desiccator and weighing.

Hot water solubles were determined by a modification of TAPPI method T 1 m-45 (*13*). The total leaching time was extended to 4 hr; at the end of each hour the liquor was removed by filtration and fresh water added. More efficient extraction was thus achieved. During filtration, the recommended, sintered glass crucibles of C-porosity became so clogged that it was difficult to filter and wash the sample with complete thoroughness. This difficulty was avoided by filtering the bark liquor through no. 1 Whatman filter paper on a Buchner funnel with suction. Upon completion of the leaching operation, and aliquot 100-ml. portion of the

Table I. Collection Data on Incense Cedar Bark Samples

Age group	Age, yr.	Tree No.	Bottom section diameter, in. Outside bark	Bottom section diameter, in. Inside bark	Middle section diameter, in. Outside bark	Middle section diameter, in. Inside bark	Top section diameter, in. Outside bark	Top section diameter, in. Inside bark
			2.5 to 3.5-ft. height		*29 to 30.5-ft. height*		*60.5 to 87.5-ft. height*	
I	195	20	23.0	17.5	14.0	12.5	5.8	5.0
	146	18	21.0	16.0	12.0	10.5	6.8	6.0
			2.0 to 3.5-ft. height		*38 to 65-ft. height*		*78 to 107-ft. height*	
II	270	13	24.0	20.5	17.5	14.5	7.2	6.0
	263	15	30.5	23.0	15.5	13.5	9.0	7.5
	261	16	37.0	30.0	21.5	19.0	7.0	6.0
	267	22	33.0	24.0	20.0	15.0	14.0	11.0
	285	23	44.5	35.5	20.5	17.5	12.5	11.0
			2.0 to 2.5-ft. height		*35 to 43.5-ft. height*		*125-ft. height*	
III	326	19	50.5	44.5	32.5	29.5	12.8	10.8
	351	21	38.5	32.5	23.5	20.5	...	...

filtrate was transferred to a tared glass dish and evaporated to dryness on a steam bath. The residue was weighed after being dried in an oven for 1 hr. at 105°C. and cooled in a desiccator.

The residual bark from the hot water extraction and the filter paper were returned to the cloth bag and the extraction with 95% ethanol was made in a Soxhlet extractor.

The results of these determinations are shown in Table II. The total extractive content ranged from 13.8 to 30.4% and increased progressively from the bottom to the top of trees in all age groups. In each case the greatest amount of extractable material was removed by water.

The hexane-soluble material was clear, soft, and sticky, varying in color from a light amber in the top bark samples to a somewhat darker one in the butt samples. A brown amorphous powder comprised the benzene solubles. The ether-soluble material was a bright red, amorphous solid which softened at approximately 233°C. The hot water extract contained tannin and carbohydrate material. A reddish-brown, amorphous solid, similar to a phlobaphene, constituted the 95% ethanol solubles.

Constituents of Extractives

A composite of the nine previously described bark samples was prepared. Five 400-gram batches of this composite were placed in cotton-cloth bags and extracted in borosilicate glass, Soxhlet-type extractors with hexane for 15 hr. The combined extract from the 2 kg. of bark was filtered, and most of the solvent removed on a steam bath. Final traces of solvent were eliminated by drying the residue in a vacuum oven at 30°C. for 1 hr. In a similar manner, the hexane-extracted bark was extracted with benzene and the benzene-soluble material isolated.

Hexane-Soluble Components. To remove the volatile oil, 70 grams of the hexane-soluble material were steam distilled; the yield of volatile material was 0.95%. The major components of the oil were previously characterized by Schorger (*12*) as furfural, alpha-pinene, dipentene, borneol acetate, and free borneol. The nonvolatile material was separated in accordance with the method outlined in Fig. 1.

On dissolving the nonvolatile material in hot acetone and cooling the solution in an ice box, white crystals of a waxlike substance separated out in a yield of 5.83%. These crystals melted at 70 to 71°C. after recrystallization from ethyl acetate and 95% ethanol. Four grams of the wax were saponified for 7 hr. with 100 ml. of 1 *N* alcoholic potassium hydroxide. The soap solution was diluted with water, and the ethanol removed by evaporation. The alcohol components of the wax were extracted from the aqueous solution with ether. The ether extract was evaporated under reduced pressure to dryness, and the residue crystallized from acetone and ethyl acetate. The crystals of the resultant alcohol components of the wax melted at 61 to 62°C. An acetate derivative, formed by treatment with acetic anhydride and pyridine, melted at 49 to 50°C. An oxidative fusion of the alcohols with potassium hydroxide (*6*) produced a mixture of corresponding acids. The acid mixture, after recrystallization from acetone, melted at 68 to 69°C. The neutral equivalent was 343.7, which showed the alcohol components of the wax to be equivalent to a mixture of behenyl and lignoceryl alcohols.

The aqueous solution containing the potassium salts of the acids from the saponification of the wax was acidified with dilute mineral acid. The resultant white precipitate was removed by filtration and washed with distilled water. White crystals separated after the precipitate was dissolved in hot acetone and the solution cooled in an ice box. They melted at 74°C. and gave a neutral equivalent of 396.0. The molecular

Table II. Percentage Extractives from Incense Cedar Bark

Values Based on Oven-Dry Weight of Unextracted Bark

Age group	Section of tree	Solvent: Hexane	Benzene	Ether	Hot water	Ethanol	Sum of five extractives
I	Bottom	3.4	1.6	1.2	8.0	1.9	16.1
	Middle	5.5	2.1	1.1	13.1	1.6	23.4
	Top	7.7	2.4	0.9	18.3	1.1	30.4
II	Bottom	3.0	2.2	0.5	9.5	1.4	16.6
	Middle	3.0	2.6	0.8	10.5	1.6	18.5
	Top	4.9	1.6	0.6	12.5	1.7	21.3
III	Bottom	2.5	2.0	1.1	6.6	1.6	13.8
	Middle	3.5	4.3	1.3	9.1	1.9	20.1
	Top	3.8	8.8	1.8	7.6	2.9	24.8

veight, determined by the Rast camphor method, was 88 and 418. These data indicated that the acid component of the wax was cerotic acid or a mixture of near omologues.

The acetone-soluble component of the nonvolatiles as further separated into neutral substances and free cids by dissolving the material in ether and extracting ith 5% potassium carbonate solution. Two grams of he free acids were treated with methanol and sulphuric cid, in accordance with the Wolff-Scholze method (*15*) r the isolation of resin acids. The resin acids melted t 182 to 184°C. and appeared to be similar to those escribed more in detail under the benzene-soluble mponents. The yield of resin acids was only 1.93%.

Twenty grams of the neutral fraction were saponified for 4 hr. with 150 ml. of 1 *N* alcoholic potassium hydroxide. The soap solution was diluted with water, and the alcohol evaporated. The resultant aqueous solution was shaken with five successive portions of ether to remove the unsaponifiable material. Colorless, needle-like crystals, in a yield of 1.07%, were obtained by dissolving the unsaponifiables in warm acetone and placing the solution in an ice box for 96 hr. These crystals gave a positive Liebermann-Burchard test for sterols and melted at 137.5 to 138.5°C. after recrystallization from 95% ethanol. An acetate derivative, formed with acetic anhydride and pyridine, melted at 125 to 126°C. The specific rotation in chloroform was $(\alpha)\ {}^{20°C.}_{D} = -$

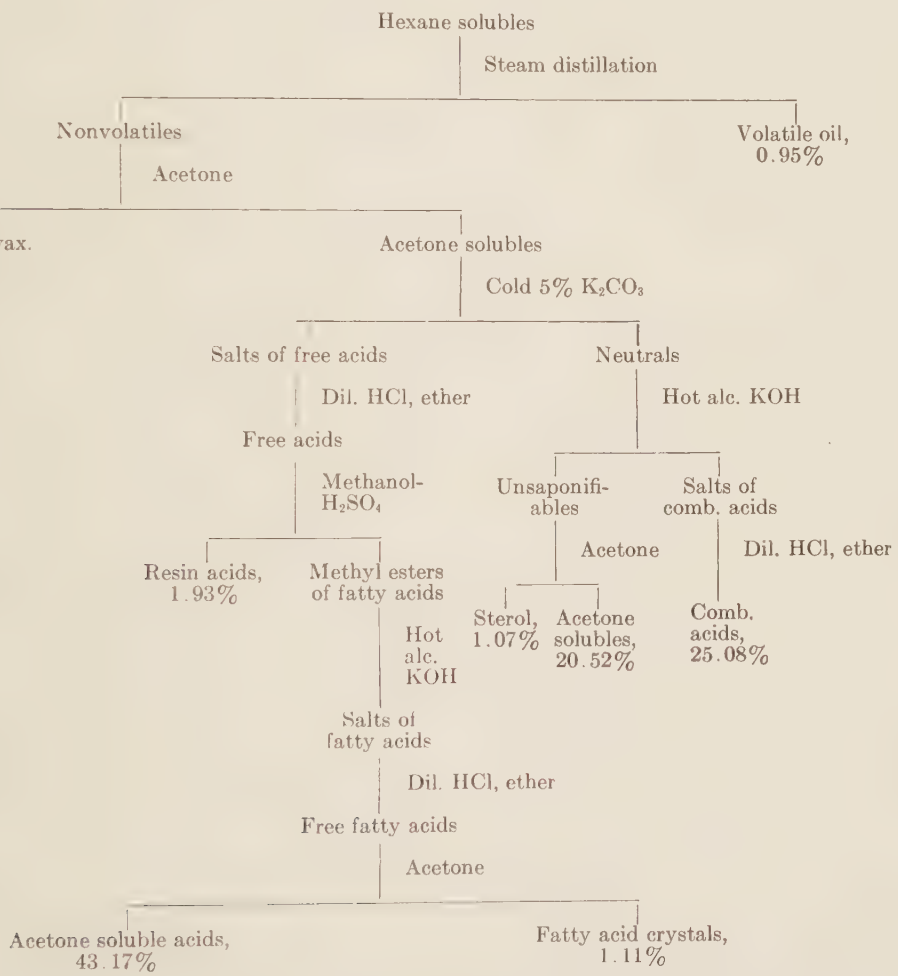

Fig. 1. Separation of hexane-soluble components of incense cedar bark

The methyl esters of the free fatty acids were saponified for 2 hr. with 150 ml. of 0.5 *N* alcoholic potassium hydroxide. The resultant free fatty acids were completely soluble in hot acetone but, on cooling the solution in an ice box, a small amount of acid crystals separated. These crystals melted at 83.5 to 84.5°C. after recrystallization from dilute ethanol and ethyl acetate. The neutral equivalent was 358.3.

The acetone-soluble fraction of the free fatty acids was an amber-colored, amorphous solid which began to soften at 50 to 53°C., had a neutral equivalent of 435.8, and gave a Hanus iodine number of 41.2. It amounted to 43.17% of the hexane solubles.

19.2 ± 1°. A material with similar properties, suggested to be a mixture of alpha and beta-sitosterol, was isolated from Sierra juniper wood (*9*).

The filtrate from the separation of the phytosterol yielded a brown, resinous solid, which was not investigated further.

The potassium salts of the combined acids were acidified with dilute mineral acid and the liberated combined acids extracted with ether. On evaporation of the ether, a soft dark brown residue was obtained that had a neutral equivalent of 446.6 and a Hanus iodine number of 80.1 The yield of combined acids was 25.08%.

Benzene-Soluble Components. Thirty grams of the

benzene extract were dissolved in ether and shaken with six successive portions of 5% potassium carbonate solution. The free acid and neutral fractions were further separated by the method outlined in Fig. 2.

The major component of the benzene extract, the free resin acid fraction, was isolated from the free acids by the Wolff-Scholze procedure (*15*) and represented 64.4% of the total benzene-soluble components. These resin acids melted at 181 to 182°C., gave a positive Liebermann-Storch test, and had a neutral equivalent of 347.7. The specific rotation in absolute ethanol was $(\alpha)_D^{20°C.} = +19.5 \pm 1°$. Although the neutral equivalent is higher than that of abietic acid, a common resin acid, resin acids with similar values have been isolated from ponderosa pine bark (*8*).

The methyl esters of the free fatty acids were treated in the same manner as those of the hexane solubles.

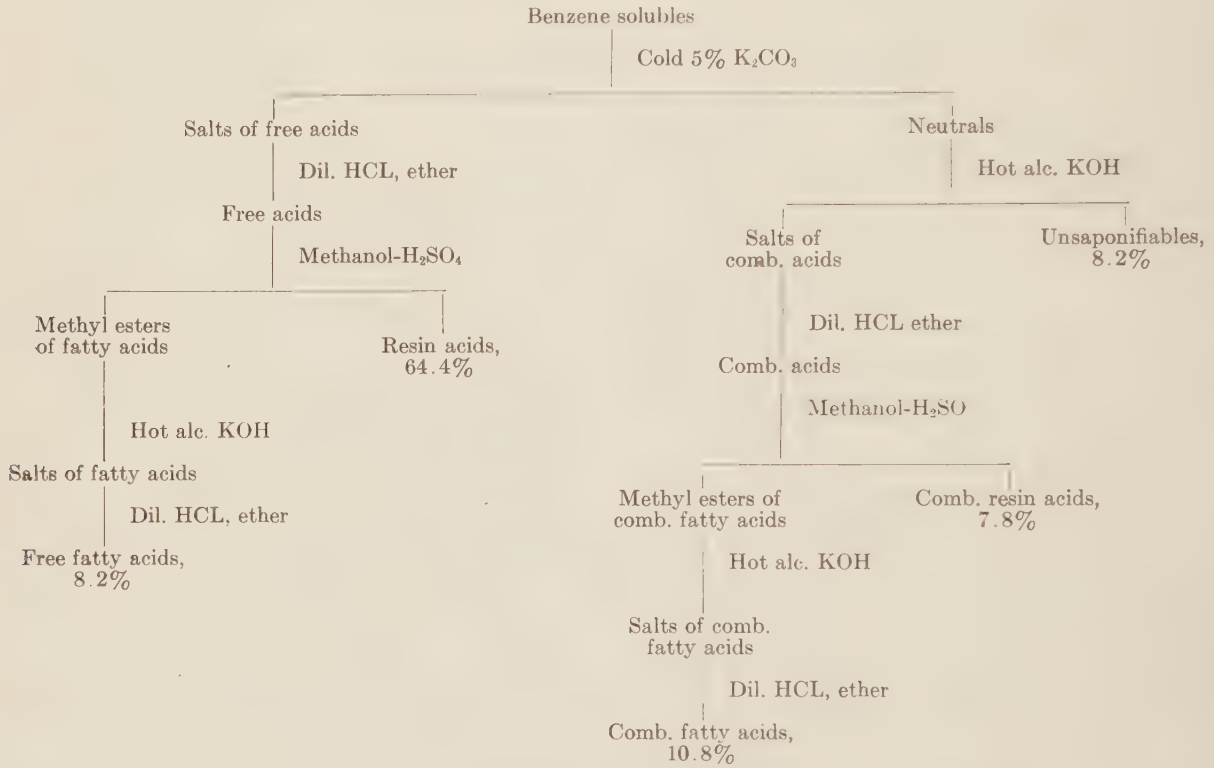

Fig. 2. Separation of benzene-soluble components of incense cedar bark

The free fatty acids were obtained as a dark brown, amorphous solid that began to soften at 66 to 68°C. This acid fraction had a neutral equivalent of 329.6 and a Hanus iodine number of 83.6. Oxidation with cold, alkaline potassium permanganate according to the method of Lapworth and Mottram (*10*) gave no significant products. This indicated the absence of oleic and linoleic acids.

The neutral fraction was saponified for 4 hr. with 100 ml. of 1 *N* alcoholic potassium hydroxide. The resultant soap solution was diluted with water, the alcohol distilled, and the unsaponifiable material extracted with ether. The dark red, amorphous unsaponifiables were obtained in a yield of 8.2% and had a Hanus iodine number of 88.5, indicating the presence of unsaturated alcohols or hydrocarbons. No crystalline products could be isolated from a variety of solvents.

The potassium salts of the combined acids were acidified with dilute mineral acid and the precipitate extracted with ether. Evaporation of the ether yielded a reddish-brown residue.

A combined resin acid fraction was obtained in yield of 7.8% from the treatment of the combined acids according to the method of Wolff and Scholze. These dark brown resin acids melted at 151 to 152°C., gave a positive Liebermann-Storch test, and had a neutral equivalent of 358.0. The specific rotation in absolute ethanol was $(\alpha)_D^{20°C.} = +20.2 \pm 1°$.

The combined fatty acid fraction from the separation of the combined resin acids gave a neutral equivalent of 366.5 and a Hanus iodine number of 101.1. Oxidation of this fraction with cold, alkaline potassium permanganante did not indicate the presence of either oleic or linoleic acids (*10*). The yield of combined fatty acids was 10.8% of the benzene solubles.

Hot Water-Soluble Components. The tannin content of the bark samples was determined by the hide powder method of the American Leather Chemists' Association (*1*). An unextracted bark sample of approximately 50 grams was used in the recommended percolation-type extractor. As shown in Table III, an extraction period of 10 hr. gave the maximum tannin yield. Further inincreases in extraction time either failed to increase the yield materially or else caused a decrease in the tannin content.

Table IV summarizes the tannin analyses of the nine bark samples. The tannin concentration was greatest in bark from near the top of incense cedar logs. Bark from the top of the youngest trees provided the highest tannin yield; bark from the bottom of the oldest trees was the least productive. The tannin content ranged from 3.5 to 7.8%.

The tannin extract gave a precipitate with gelatin, a

Table III. Effect of Extraction Time on Tannin Yields

Percentages Based on Oven-Dry Weight of Unextracted Bark

Component	Time, hr. 4	6	8	10	14
Tannin	3.6	4.0	4.1	4.3	4.2
Nontannin	6.6	6.1	7.4	8.1	7.6
Soluble solids	10.2	10.1	11.5	12.4	11.8
Insoluble solids	1.5	0.5	1.8	1.9	1.5
Total solids	11.7	10.6	13.3	14.3	13.3
Tannin/soluble solids	0.35	0.40	0.36	0.35	0.36

green color with ferric chloride, and a precipitate when boiled with dilute sulphuric acid, indicating the tannin to be of the phlobatannin class. The purity of the tannin extract was low, ranging from 35 to 43%.

In addition to the tannin, the hot water extract contained considerable amounts of a carbohydrate material which could be separated from the tannin through its insolubility in 95% ethanol.

Five 100-gram batches of unextracted bark, ground to pass a 20-mesh screen, were heated in 5-liter round-bottom flasks containing 3 liters of distilled water for 24 hr. on a steam cone. The extract from the 500 grams of bark was evaporated slowly at room temperature to 600 ml. This thick syrup was poured slowly into 3 liters of 95% ethanol with agitation. The precipitated carbohydrate material was removed by filtration, redissolved in a small volume of hot water, and reprecipitated from a fresh portion of ethanol. After three additional precipitations, a light pink carbohydrate product was obtained. The filtered precipitate was washed with 95% ethanol and dried in a desiccator. The yield was approximately 9% of the oven-dry unextracted bark.

The dried carbohydrate material began to decompose at 260°C. A maximum reducing sugar content of 65.9%, calculated as glucose, was reached after 8 hr. hydrolysis with 2% sulphuric acid (Table V). In an attempt to account for the nonreducing fraction, a water solution of the carbohydrate material was treated with hide powder in accordance with the method of the American Leather Chemists' Association for the determination of tannin (*1*). The crude carbohydrate fraction, as isolated from 95% ethanol, was found to contain 24.0% tannin, 10.2 % water insolubles, and 65.8% nontannin. Hence an alcohol-insoluble tannin material that comprised almost 40% of the total tannin present in the hot water extract was found in this fraction. The insolubles were apparently formed while drying the original 95% ethanol precipitate. The amount of nontannin material corresponded to that of the total reducing sugars present after hydrolysis of the crude carbohydrate material.

Table V. Total Reducing Sugar Determinations

Percentages Based on Oven-Dry Weight of Crude Carbohydrate Material

Length of hydrolysis treatment, hr.	Total reducing sugars, %
0	0.0
4	61.6
8	65.9
15	62.8
21	60.7

The nontannin solution that resulted from treating the crude carbohydrate fraction with hide powder was removed by filtration and evaporated slowly at room temperature to a syrup. When this syrup was poured into a large volume of ethanol with agitation, a white carbohydrate precipitate separated out that analyzed 95.7% reducing sugar after 8 hr. hydrolysis. The optical rotation of this purified carbohydrate material was $(\alpha)_D^{20°C.} = + 133.2 \pm 1°$.

Table VI. Approximate Percentage Composition of the Total Reducing Sugars in the Carbohydrate Material

Values Based on Oven-Dry Weight of Total Reducing Sugars

Pentoses	21.6
Galactose	36.3
Mannose	5.1
Uronic acid	3.0
Glucose (by difference)	34.0
Total	100.0

The approximate composition of the total reducing sugars is given in Table VI. The analyses were performed on the crude carbohydrate material. Pentoses were determined by the method of the Association of Official Agricultural Chemists (*2*). Uronic anhydride was found by Maher's procedure (*11*). One gram of the carbohydrate material was oxidized with nitric acid according to the Bureau of Standards procedure (*3*). The resultant yield of mucic acid gave the percentage of galactose present. Mannose was determined, in the usual manner, by precipitation as mannose phenylhydrazone. Glucose was calculated by difference.

Analysis of Extractive-Free Bark

The analysis of extractive-free incense cedar bark, prepared according to TAPPI method T 12 m-45, is shown in Table VII. Lignin and methoxyl determinations were made in accordance with TAPPI methods T 13 m-45 and T 2 m-43, respectively. Pentosans were ascertained by Tollen's procedure (*13*). The acetyl determination was made by the Freudenberg and Harder method (*5*).

Table IV. Analysis of Tannin Extracts from Incense Cedar Bark

Percentages Based on Oven-Dry Weight of Unextracted Bark

Age group	Sample	Total solids	Soluble solids	Insolubles	Tannin	Nontannin	Tannin × 100 / Soluble solids
I	Bottom	10.4	9.5	0.9	3.9	5.6	41.0
	Middle	17.9	16.5	1.4	5.7	10.8	35.0
	Top	21.8	20.4	1.4	7.8	12.6	38.0
II	Bottom	14.3	12.4	1.9	4.3	8.1	35.0
	Middle	13.1	11.4	1.7	4.1	7.3	36.0
	Top	19.1	17.4	1.7	6.1	11.3	35.0
III	Bottom	8.7	8.1	0.6	3.5	4.6	43.0
	Middle	14.1	11.8	2.3	4.3	7.5	36.0
	Top	13.7	11.1	2.6	4.5	6.6	41.0

Table VII. Percentage Components of Extractive-Free Bark

Values Based on Oven-Dry Weight of Extractive-Free Bark

Ash	1.0
Lignin	46.5
Holocellulose (corrected for lignin)	51.3
Pentosans	10.7
Methoxyl	3.4
Acetyl	0.7

Because of filtration difficulties, holocellulose could not be prepared by the TAPPI procedure T 9 m utilizing chlorine and monoethanolamine. Similar results have been experienced by other bark investigators. The chlorite method (*7*, *14*) was more successful. The

Table VIII. Percentage Content of Chlorite Holocellulose

Values Based on Oven-Dry Weight of Extractive-Free Bark

Time of treatment hr.	*Holocellulose*	*Lignin on holocellulose*	*Holocellulose corrected for lignin*	*Sum of total lignin and holocellulose*
3	57.8	5.6	52.2	98.7
4	54.5	3.0	51.5	98.0
5	47.1	0.8	46.3	92.8
6	45.8	0.8	45.0	91.5

lignin content of the holocellulose, however, could not be reduced below 5.6% without appreciable degradation of the holocellulose (Table VIII).

PORT ORFORD CEDAR BARK

Collection and Preparation of Samples

The samples used for this investigation were collected in May, 1950, from Oregon trees felled during the same week within a 2-mile radius. The collection data are shown in Table IX. The sampling and preparation of the bark for analytical use were done in the same manner as that described in preceding sections on incense cedar.

Distribution of Extractives

The extraction procedure was identical with that used for incense cedar. Table X gives a summary of the extractive percentages. The total extractive content ranged from 15.6 to 25.7%. Bark samples taken near the top of the logs contained the greatest amount of extractable material; the least amount was found in bark from the bottom of the logs. In all samples the greatest amount of material was removed with hot water; variations in the total extractives from individual samples were due mainly to differences in the percentage of this extractive.

Constituents of Extractives

The hexane extract was a clear, sticky material varying in color from a light amber in the top bark samples to a brown in the bottom samples. A dark brown, resinous solid that softened between 90 and 100°C. was removed from the bark by benzene. The ether-soluble material was a brilliant red, amorphous solid that softened at approximately 210°C. The hot water extract contained the bark tannin and soluble carbohydrate materials. A reddish-brown, phlobaphene-like material was removed from the bark with 95% ethanol.

Tannin Content. Tannin analyses of Port Orford cedar bark were carried out by the hide powder method (*1*). Extraction of the bark for 8 hr. gave the maximum tannin yield. Table XI gives the complete tannin analyses of the nine composite samples. The purity of the tannin extracts ranged from 41 to 53%. Bark from the tops of the logs contained the greatest amount of tannin, while bark from the bottom of the logs contained the least, the yields ranging from 4.2 to 7.0%. The tannin extract gave a precipitate with gelatin, a green color with ferric chloride, and a precipitate when boiled with dilute sulphuric acid; these tests are characteristic of phlobatannins.

WESTERN RED CEDAR BARK

An earlier investigation of western red cedar bark (*4*) showed the extractive-free bark to contain ash, lignin, holocellulose, and pentosans in amounts similar to those found in incense cedar bark. The total extractive content of the former, as determined by extraction with alcohol-benzene, alcohol, and hot water, was approximately 11%. This relatively low value was not unexpected, however. Since the logs from which the bark samples were collected had been exposed to the actions of both salt and fresh water for considerable time before the sampling, a significant part of the hot water solubles may have been removed before chemical investigations were begun.

Table IX. Collection Data on Port Orford Cedar Bark Samples

Age group	*Age, yr.*	*Tree No.*	*Bottom section diameter, in.* Outside bark	Inside bark	*Middle section diameter, in.* Outside bark	Inside bark	*Top section diameter, in.* Outside bark	Inside bark
			1.0-ft. height		*42-ft. height*		*83-ft. height*	
I	161	7	27.2	19.2	13.3	11.8	6.6	6.0
	97	7N	...	...	...	...	...	...
	93	6N	...	...	...	...	...	...
	98	1N	...	...	...	...	...	...
			2.0-ft. height		*32 to 43-ft. height*		*65 to 91-ft. height*	
II	242	8	32.5	25.0	17.0	14.0	10.5	9.5
	257	2	26.5	22.0	15.7	14.5	7.6	7.0
	257	9	17.3	15.8	12.5	11.5	6.1	5.5
	253	10	29.5	22.0	19.2	16.2	8.9	8.3
			2.5 to 3.5-ft. height		*39.5 to 45.5-ft. height*		*85.5 to 133.5-ft. height*	
III	328	1	57.0	42.5	29.5	25.0	17.5	15.7
	297	3	30.0	25.0	13.1	12.6	6.0	5.5
	291	4	43.0	35.5	19.5	18.0	7.0	6.5
	336	5	52.0	40.0	30.0	26.3	11.7	10.5
	327	6	48.0	38.0	31.0	26.7	23.0	19.6
	285	11	29.5	24.0	18.1	16.3	7.6	7.0

Table X. Percentage Extractive Content of Port Orford Cedar Bark

Values Based on Oven-Dry Weight of Unextracted Bark

Age group	Section of tree	Solvent: Hexane	Solvent: Benzene	Solvent: Ether	Hot water	Ethanol	Total of five extractives
I	Bottom	5.1	1.8	1.8	8.8	3.3	20.8
	Middle	6.1	1.0	2.1	13.8	2.7	25.7
	Top	4.6	0.8	1.2	12.4	1.4	20.4
II	Bottom	3.4	0.8	1.5	8.2	3.3	17.2
	Middle	3.0	1.2	1.1	8.6	2.5	16.4
	Top	4.6	1.6	1.3	13.1	1.6	22.2
III	Bottom	3.7	1.1	1.6	7.9	1.9	16.2
	Middle	3.0	0.9	1.4	8.5	1.8	15.6
	Top	3.1	0.9	0.9	11.8	1.5	18.2

Collection and Preparation of Samples

Samples used in this investigation were collected in June, 1950, south of Oakridge, Ore., from trees felled at an elevation of 4000 ft. Inasmuch as young trees were not available, those obtained were divided into only two age groups. Table XII gives a summary of the collection data. The procedures used in sampling and preparing the bark for further use were similar to those described for incense cedar bark.

Table XI. Analysis of Tannin Extracts from Port Orford Cedar Bark

Percentages Based on Oven-Dry Weight of Unextracted Bark

Age group	Sample	Total solids	Soluble solids	Insolubles	Tannin	Non-tannin	Tannin × 100 / Soluble solids
I	Bottom	11.5	11.0	0.5	5.2	5.8	47.0
	Middle	17.9	16.4	1.5	7.0	9.4	43.0
	Top	14.2	12.8	1.4	5.5	7.3	43.0
II	Bottom	9.6	8.7	0.9	4.6	4.1	53.0
	Middle	10.8	9.6	1.2	4.2	5.4	44.0
	Top	15.5	14.2	1.3	6.3	7.9	44.0
III	Bottom	10.0	9.2	0.8	4.9	4.3	53.0
	Middle	10.1	8.6	1.5	4.2	4.4	49.0
	Top	14.9	13.6	1.3	5.6	8.0	41.0

Constituents of Extractives

The major extractives from all samples were hot water-soluble materials, but significant amounts of hexane and benzene solubles also were found. The hexane extract was a clear, amber-colored sticky resin, and the benzene-soluble material a solid, brown resin. The red ether extract and the reddish-brown phlobaphene isolated with 95% ethanol were similar in nature to those obtained from the other two cedar barks.

Table XII. Collection Data on Western Red Cedar Bark Samples

Age group	Age, yr.	Tree No.	Bottom section diameter, in. Outside bark	Bottom section diameter, in. Inside bark	Middle section diameter, in. Outside bark	Middle section diameter, in. Inside bark	Top section diameter, in. Outside bark	Top section diameter, in. Inside bark
			1.0 to 2.5-ft. height		42 to 68-ft. height		67 to 124-ft. height	
I	226	14	34.0	32.0	18.8	17.0	11.0	10.0
	237	39[a]	21.0	20.0	11.0	10.5	5.5	5.0
	223	40	36.5	36.0	22.5	21.0	9.2	8.2
	248	41	40.4	39.2	22.0	20.5	13.0	11.8
	250	35	22.0	21.0	11.6	11.0	8.0	7.5
	282	36	24.0	23.0	12.7	11.9	7.0	6.5
			1.5 to 4.5-ft. height		38.5 to 45.5-ft. height		70 to 85-ft. height	
II	336	37	24.0	22.5	14.1	13.5	7.8	7.0
	374	38	23.0	21.5	14.2	13.1	7.5	7.0
	314	24	30.3	29.5	16.0	15.0	9.6	9.0

[a] Short tree.

Distribution of Extractives

The extraction procedure described for incense cedar bark was used in making the western red cedar bark determinations. The distribution and amounts of extractives are shown in Table XIII. Bark from the tops of the logs contained the largest amount of extractable materials, while the bark from the bottom contained the smallest amount. The percentage of total extractives ranged from 18.1 to 29.0%.

Table XIII. Percentage Extractive Content of Western Red Cedar Bark

Values Based on Oven-Dry Weight of Unextracted Bark

Age group	Section of tree	Solvent: Hexane	Solvent: Benzene	Solvent: Ether	Hot water	Ethanol	Total of five extractives
I	Bottom	2.7	2.0	2.3	10.0	1.1	18.1
	Middle	5.6	3.4	2.4	12.3	1.1	24.8
	Top	7.4	2.9	2.3	14.5	0.6	27.7
II	Bottom	3.9	3.4	2.6	11.3	1.0	22.2
	Middle	6.2	4.3	2.0	13.1	1.1	26.7
	Top	9.0	2.6	1.8	14.6	1.0	29.0

Table XIV. Analysis of Tannin Extracts from Western Red Cedar Bark

Percentages Based on Oven-Dry Weight of Unextracted Bark

Age group	Sample	Total solids	Soluble solids	Insolubles	Tannin	Non-tannin	Tannin × 100 / Soluble solids
I	Bottom	12.0	10.1	1.9	4.8	5.3	48.0
	Middle	14.5	12.4	2.1	5.1	7.3	41.0
	Top	15.0	13.4	1.6	5.3	8.1	40.0
II	Bottom	12.0	9.8	2.2	4.7	5.1	48.0
	Middle	13.6	11.4	2.2	5.0	6.4	44.0
	Top	18.4	16.2	2.2	6.5	9.7	40.0

Tannin Content. Tannin analyses were made by the hide powder method (*1*) after an extraction period of 8 hr. The tannin yields which ranged from 4.7 to 6.5% are shown in Table XIV. The purity of the tannin extract ranged between 40 to 48%. Bark from the tops of the logs contained the most tannin, bark from the bottom of the logs the least. Formation of a precipitate with gelatin, a green color with ferric chloride, and a precipitate when boiled with dilute sulphuric acid showed the bark tannin to be of the phlobatannin class.

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Properties of Synthetic Rubbers and Thermoplastics as Insulation for Electric Cables

E. W. DAVIS

The essential properties of an insulating and sheath compound for an electric cable depend primarily on the service conditions including operating voltage, current load, system characteristics, temperature of surroundings, exposure to heat, light, and moisture—and for cables used in the pulp and paper industry, exposure to many chemical solutions not generally found in other industries. Replies to a recent questionnaire prepared by the TAPPI Subcommittee on Cables and sent to all of the operating plants of the pulp and paper industry showed that the predominant causes of cable failures have been as follows: (1) deterioration due to age and oxidation; (2) deterioration due to exposure to oil, water, sunlight, and chemicals; (3) improper termination and splicing; and (4) damage to cable during installation. There was a considerable spread between the assigned causes of the cable failures as reported by the plants employing various processes of pulp treatment (sulphite, sulphate, groundwood, rag, etc.) but there was a definite pattern which assigned the four causes listed above as being predominantly important. The paper presented herewith, points out how, by employing some of the synthetic rubbers and thermoplastics available today, the wire and cable failures due to the first two causes listed above can be considerably reduced. Comparison of the properties of the synthetic rubber compounds with those employing natural rubbers as a base are presented.

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As a result of chemical research and technological developments during and subsequent to World War II, there has become available to electrical engineers concerned with the distribution and utilization of electrical energy, as well as those interested in communications—a new field of electrical insulating materials that offers a wide range of electrical, chemical, and physical properties consistent with longer service life expectancy than thought possible only a decade ago. This brief conference paper will call attention to a few of these materials and point out some of their characteristics which make them predominantly superior to those available prior to World War II.

Prior to World War II, the common insulating materials were as shown in Table I.

Table II is an extension of Table I to show that to the original three types of insulating materials there can be added two very important materials that bid fair to displace generally the natural rubber compounds, to replace much of the varnished cambric, and even

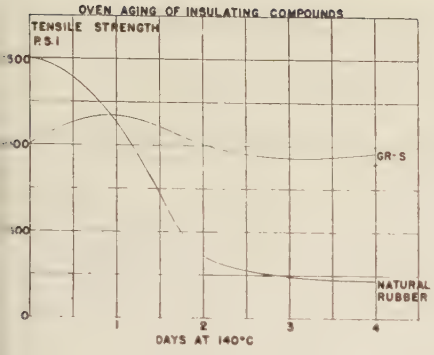

Fig. 1

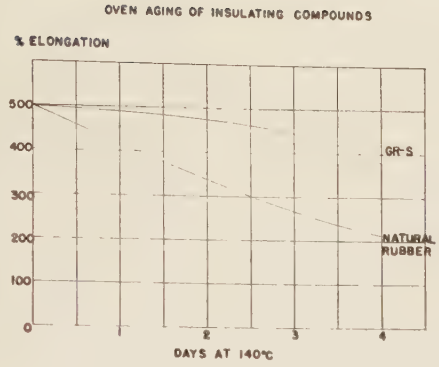

Fig. 2

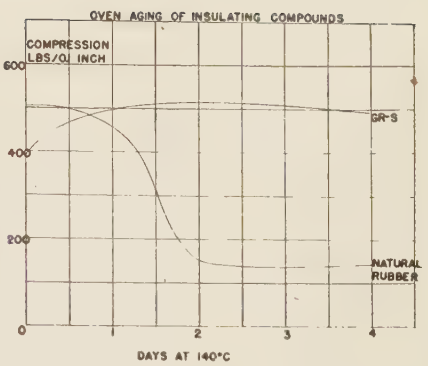

Fig. 3

encroach into the fields where paper insulation has been used. These new insulating materials are the synthetic rubber compounds and the thermoplastics (polyvinyl chloride and polyethylene).

Table I. Common Insulating Materials Prior to World War II

I.	Natural rubber compounds	Code
		Performance
		Heat resisting
		Ozone resisting
		Low S.I.C.
		Submarine
II.	Varnished cambric	
III.	Paper	Dry for communication cables
		Impregnated for power cables

The synthetic rubber insulating compounds and the thermoplastics which are listed in Table II are distinctly developments of laboratories and factories during and subsequent to World War II and are the only modern materials under discussion in this paper.

The essential properties of an insulating compound for an electric cable depend primarily on the service conditions including operating voltage, current load, system characteristics, temperature of surroundings, exposure to heat, light, and moisture as well as dielectric constant for communication and signal cables. For power cables some of the essential properties are as listed in Table III. For communication cables, there must be added to the list of essential properties for power cables—dielectric constant, power factor at various frequencies, insulation resistance, and special emphasis on the electrical stability in the presence of moisture or water. The lack of electrical stability of many thermoplastic or thermosetting insulating materials makes many of them totally unsuited for communication cables even though they may have a reasonably good service record in power cables.

Table II. Available Insulating Materials Subsequent to World War II

I.	Natural rubber compounds	Performance
		Heat resisting
		Ozone resisting
		Low S.I.C.
		Submarine
II.	Synthetic rubber compounds	Code
		Performance
		Heat resisting
		Ozone resisting
		Low S.I.C.
		Submarine
III.	Varnished cambric	
IV.	Thermoplastics	
	Polyvinyl chloride	Moisture resisting
		Low temperatures
		High temperatures
	Polyethylene	
V.	Paper	Dry for communication cables
		Impregnated for power cables

The relative importance of any one of these properties as compared to the others depends upon the service conditions, and there are some special service conditions that may make some unlisted properties of extreme importance (such as around chemical plants, oil refineries, refrigeration plants, etc.). Ozone re-

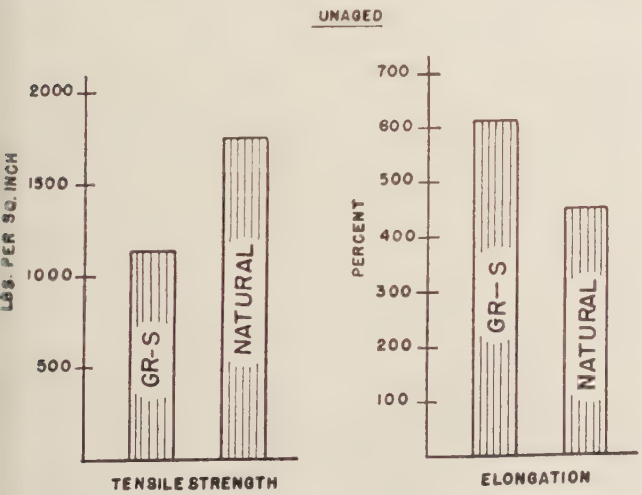

Fig. 4. Heat-resisting rubber compounds

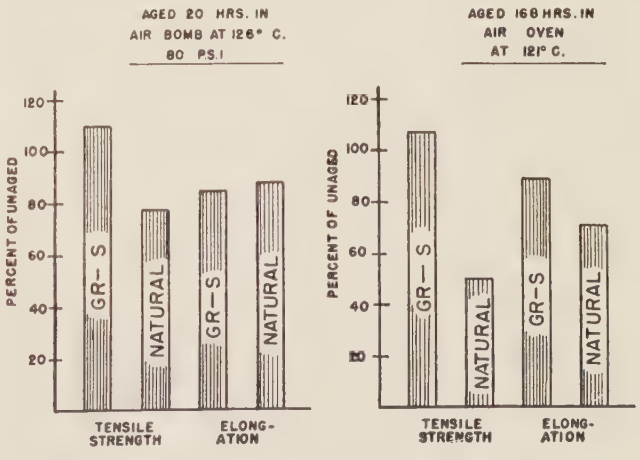

Fig. 5. Heat-resisting rubber compounds

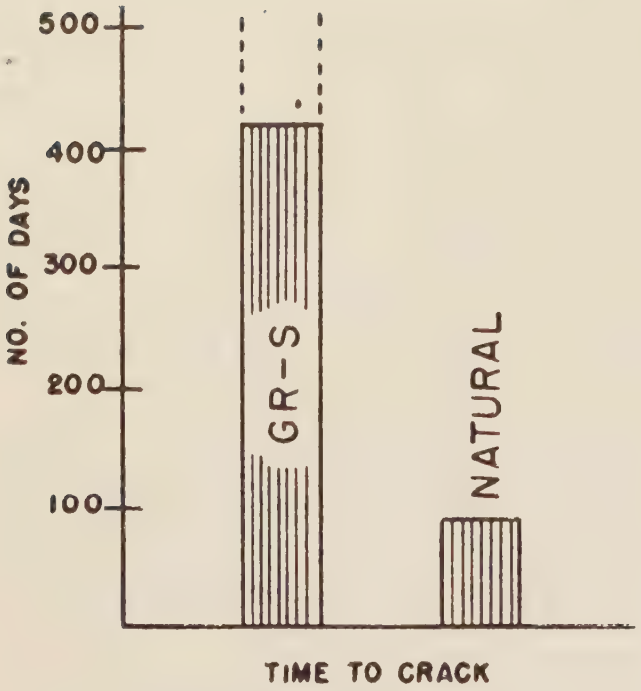

Fig. 6. Heat-resisting rubber compounds (aged in sun out-of-doors)

sistance and corona resistance of insulating compounds are of no importance for low voltage cables (under 2000 volts) and moisture resistance of little importance for cables having continuous lead sheaths from terminal to terminal. Cracking temperature, shattering temperature, and flexibility become exceedingly important properties for the thermoplastics in cables to be handled at low temperature, while the softening point, flow point, deformation, migration of plasticizers are equally important for these same insulating materials to operate at the higher temperatures.

Figures 1, 2, and 3 show the deterioration of the heat-resistant or superaging grade of rubber insulations made with natural rubber and one of the most commonly used synthetic rubbers (GR-S) during a reasonably severe accelerated aging at 140°C.

It should be noted that while the initial tensile strength and compression resistance of the natural rubber compound are considerably higher than for the synthetic rubber type, this relative comparison changes in less than 1 day at the accelerated test temperature, and that after 4 days these two essential physical properties show little or no change while those for the natural rubber compound are only approximately one third of the original value.

Table III. Essential Properties of Rubber Insulation for Power Cables

Physical properties	Original and after aging	
	Tensile strength	
	Elongation	
	Compression	
Electrical properties	Original and after aging	
	Dielectric strength	
	Impulse strength	
	Power factor (for high voltage cables)	
Moisture resistance	Original and after aging	
	Mechanical moisture absorption	
	Electrical stability	
Miscellaneous	Light resistance	
	Ozone resistance, Corona resistance	for high voltage cables

Figure 4 and 5 show similar data for these same compounds prior to and after a similar aging test at a different test temperature.

The data shown in these five figures are typical of any grade of natural rubber and synthetic rubber compounds.

Figure 6 shows the relative light resistance of insulating compounds made with the two types of rubber under discussion. This greater resistance to light checking of the synthetic rubber compound is of prime importance where such insulation may be exposed to light as at terminations of signal or control cable.

With the increasing use of nonleaded cables in underground and underwater cables, the stability of the rubber insulation when exposed to water is of extreme importance. There are no cable protective coverings on insulated wires and cables that are completely impervious to the passage of water—hence the electrical insulation on the conductors under the protective covering should be as stable as possible if and when the water gets through the protective coverings. This is particularly important for communication cables where any increase of the dielectric constant may result in an increase of attenuation to a point where the cable is no longer serviceable. This instability of some rubber insulating compounds greatly retarded the use of nonleaded submarine cables for many years. For years, only gutta percha was used for deep-sea nonleaded telegraph and telephone cables because it was the most stable insulating material available. Because of an unfortunate experience of one of our Federal agencies with a reasonably long submarine communication cable, many years ago, considerable research was carried out by the Bureau of Standards and some of the cable manufacturers to develop a rubber insulation that was stable electrically and physically when exposed to water.

Figure 7 shows increase of capacitance of one of these insulating compounds when immersed in water at 70°C. (This high temperature was chosen to accelerate the test.) This compound was made with natural rubber. In Fig. 7 is shown the increase of capacitance of a similar compound made with one of the synthetic rubbers.

It is a well-known fact that moisture resistance of a rubber insulation may decrease with the age of the material used. This figure shows that while the natural rubber compound has considerably higher

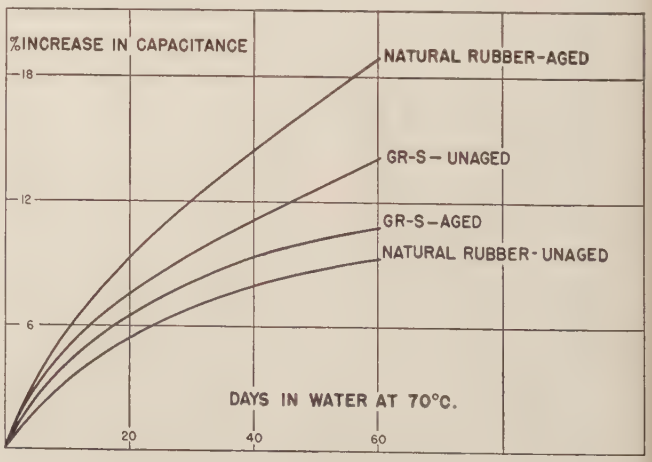

Fig. 7

able IV. Properties of Polyvinyl Chloride for Power Work

Property	*Characteristics*	*Remarks*	*Suitability for power work: Favorable*	*Suitability for power work: Unfavorable*
ielectric strength	High	...	x	..
electric constant	High	...	..	x
ower factor	High	...	..	x
sulation resistance	Fair	Good enough	x	..
nsile strength	High	...	x	..
ongation	Fair	...	x	..
idation and heat	Good	...	x	..
ater	Excellent	If so compounded	x	..
l	Good	...	x	..
rona	Good	...	x	..
one	Excellent	...	x	..
ids and alkalies	Good	...	x	..
ame	Good	...	x	..
nlight	Excellent	...	x	..
formation	Fair	When heated	x	x
acking	Fair	When cold	..	x
attering	Poor	When cold	..	x
c resistance	Good	...	x	..
acking	Good	From arc or failure	x	..

te of capacitance increase after it has been exposed o an accelerated aging test, the synthetic rubber compound shows a decrease of the rate after being exposed o the same accelerated aging test. Long-time immersion tests at lower temperatures confirm this same phenomenon.

Table IV and V list the electrical and physical properties of polyethylene and the ordinary polyvinyl chloride together with their favorable and unfavorable characteristics for power service.

The excellent electrical properties of polyethylene make the use of this material for power cables particularly tempting, but some of the physical characteristics and its susceptibility to contamination have somewhat retarded its use.

The use of the polyvinyl chloride for power work has been generally limited to low voltage cable (including street lighting cables). Its high dielectric constant and the high power factor of such compounds to date make the material undesirable for cable to operate at the higher voltages.

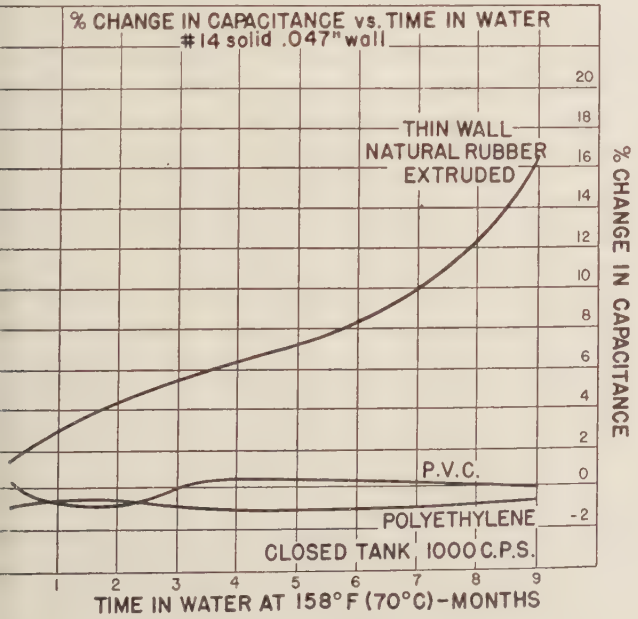

Fig. 8

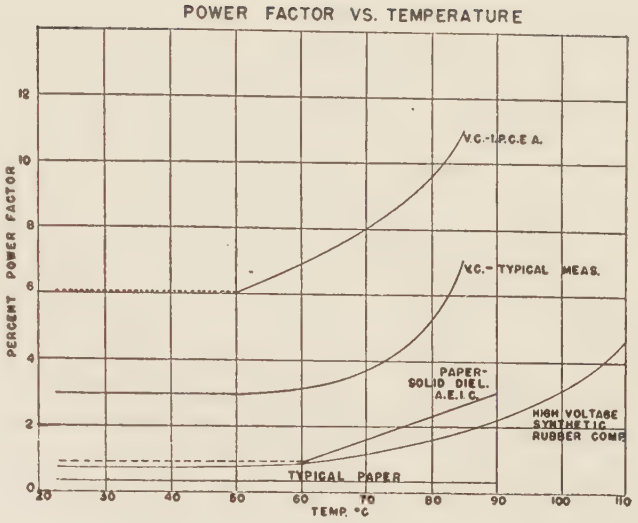

Fig. 9

The low dielectric constant of polyethylene makes it the best insulating material of the solid type for communication cables. It also is the most stable material electrically when exposed to water.

The dielectric constant of the polyvinyl chloride is not so favorable as that of polyethylene. When properly compounded, its stability when exposed to water is excellent.

Figure 8 shows the change of capacitance of a communication cable having conductors insulated with a thin wall of rubber insulation (15 to 20 mils)—and a similar cable having the same thickness of polyethylene and polyvinyl chloride.

In the early part of this paper, it was mentioned that rubber compounds made with synthetic rubbers may encroach into the field of high voltage cables where paper and varnished cambric have been the accepted

Table V. Properties of Polyethylene for Power Work

Property	*Characteristics*	*Remarks*	*Suitability for power work: Favorable*	*Suitability for power work: Unfavorable*
Dielectric strength	High	...	x	..
Dielectric constant	Low	...	x	..
Power factor	Low	...	x	..
Insulation resistance	High	...	x	..
Tensile strength	High	...	x	..
Elongation	High	...	x	..
Oxidation and heat	Excellent	If protected by antioxidant	x	..
Water	Excellent	Nearly perfect	x	..
Oil	Good	...	x	..
Corona	Poor	Damaged by discharges	..	x
Ozone	Good	...	x	..
Acids and alkalies	Excellent	...	x	..
Flame	Poor	Can be made flameproof but not for insulation	..	x
Sunlight	Good	If protected by addition of pigment and antioxident	x	..
Deformation	Good	Up to 190°F., liquid at 230°F.	x	..
Cracking	Excellent	With cold	x	..
Shattering	Good	With cold	x	..
Arc resistance	Poor	...	..	x
Tracking	Poor	From arc or failure	..	x
Coefficient of expansion	High	About three tiines that of rubber	..	x

insulating materials. Figure 9 shows the measured power factor versus temperature of varnished cambric, paper (solid type), and a synthetic rubber compound suitable for high voltage cable. Over the entire range of temperatures, the synthetic rubber insulating compound shows a power factor somewhat lower than specified in the AEIC specification. Life tests now in process in one manufacturer's laboratory indicate the suitability of this synthetic rubber compound for high voltage cable service.

Most specifications for rubber insulating compounds have been written around physical and electrical properties of the unaged materials. With the development of the heat-resisting or superaging compounds, there crept into specifications physical properties after some type of accelerated aging procedure. No attention was given to deterioration of electrical properties, ozone resistance, or moisture resistance after the accelerated aging test. Experience has shown that deterioration of these properties is of as much if not more importance than the deterioration of the physical properties. Ozone resistance of many natural rubber compounds decreases as the compound ages—and the rate of moisture absorption may increase.

In fact, one cable manufacturer is advocating test for ozone resistance and the stability of insulation in the presence of moisture after some form of an aging procedure. With synthetic rubber compounds, this appears to be the next step in an attempt to specify factory test procedures that will assure customers stability of these properties throughout the life expectancy for the cables —particularly where a loss of these properties may result in cable failures.

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Belting Paper Machine Cone Drives

SAMUEL L. ALLEN

This article is based on the author's experience working with paper machine builders and paper mills during the past 15 years as consulting engineer with J. E. Rhoads & Sons, one of the oldest suppliers of transmission belting for the paper industry. This information is particularly important today when paper mills everywhere are straining for higher machine speeds. Little information has been available on this subject to date, and, the information that has been available has been scattered through engineering handbooks and articles dealing with a particular phase of the problem. It is the intent here to gather this material together, insert the data the author has developed through his experience, and present it under a single heading.

Today, there are two types of belting generally used on line shaft driven paper machines—leather and rubber. The differences between these two are particularly important today because of the demand for increased machine speeds. Leather belting has a higher sustained horsepower rating than its equivalent rubber belt under identical tensions and belt speed. This is the result of the leather fibers being intricately woven together producing a coefficient of friction about twice that of rubber belting. The natural weave of these fibers also gives leather belting less internal friction and a longer service life.

While rubber belting is truer running, has more lateral stiffness, and withstands edge wear better than leather, these are not controlling factors in belt selection when increased machine speed is the primary consideration. Rubber belting has to be run at a much higher tension because of its low coefficient of friction. In addition, rubber is more affected by a change in this tension—a slight reduction in tension cuts power transmission capacity substantially.

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Leather is different from rubber because it can be dressed to maintain its grip and prolong its life. Rubber belting cannot be penetrated by any belt dressing. Leather is lighter in weight, therefore is less affected by centrifugal force at high belt speeds of 5000 to 6000 f.p.m.

Water tightens a rubber belt and loosens a leather belt so water should be kept away from them. Leather will pull down on the cones better due to its flexibility. Leather is completely dependable and will show signs of failure before it actually fails.

Just as there are basic differences between leather and rubber so there are differences within each of these general classifications. For instance, in the case of leather we have special tanned versus oak tanned leather.

Special tanned is more flexible, has a higher tensile strength, and will conform to the cones better. Because of its increased flexibility it will run over smaller pulleys at higher speeds and last longer than the hard oak tanned belting. It is less affected by water vapor, oil, and vapors of corrosive acids than oak. The peak and running load capacity are higher for special tanned than for oak. The stretch characteristics are about the same.

Paper mills vary considerably but belt drive layouts are usually quite similar. The line shaft may be in the basement or on the wall alongside of the machine or possibly on the machine floor. Each plant has its own special problems that have to be solved but generally speaking, water, steam vapor, heat, dust, and oil are all present in varying degrees.

Machines having the line shaft on the wall subject the belts to more heat and water vapor than the basement line shaft machine. This may mean shorter belt life and possibly more maintenance. With the drive in the basement, belts run cooler and are subjected to somewhat less water vapor. In older mills more oil is pres-

and may get on the belts from oil-soaked floors ound the belt slots. Proper oiling and maintenance reduce or eliminate the oil problem which shortens t life and makes them slip.

CENTER DISTANCE

A great majority of the cone drives are nearly vertical h center distances ranging from a minimum of about ft. to a maximum of around 22 ft. The short centers generally used on smaller machines with belt widths to 12 to 14 in. Wider belting would cause trouble less the cone tapers were $^1/_2$ in. per ft. on the di- eter or less. The longer center drives present more of roblem in keeping belts tight at the maximum belt ed due to centrifugal force which elongates a leather approximately $^1/_2$% of its length at 6000 f.p.m. enter distance of about 14 to 15 ft. would be ideal on large high-speed machines with the tight side of the on the bottom and with a cone taper of $^3/_4$ in. per f face or less.

Crossed Belts on cone pulleys are often a necessity and se work best on long centers, low taper, and with es of nearly the same diameter. Usually the belt dth on these drives is not over 12 in. A crossed belt ll lay flat on the cones but the edge of the belt on the gh side of the cones will have to stretch out more than e other. One or two shortenings should take care of is. The shifter shoes will have to be located so as to in line with the belt edges. Whether the cross is a t or right-hand twist makes little difference in actual eration.

Idlers for cone belt drives are being used in some cases eliminate the effects of belt stretch which might use a shutdown in the middle of the week if they ren't used. Idlers are expensive and their use de- nds upon the cost of idlers for the whole machine rsus down time chargeable to the belts. Many operly maintained belt-driven machines without ers have run as long as 3 to 4 yr. or more without any wn time charged to the belts. All shortenings are ade during regular shutdowns or at the time of wire or t changes. Quick-drying of cemented belt laps akes this possible.

Short center cone belt drives down to 4 ft. are being n with manual take-up on belt stretch provided by ounting the gear unit on splines or slide rails for ke-up with a jordan-type coupling used on the inshaft the machine. Automatic adjustment of belt tension uld be added to this arrangement by using air cylin- rs or calibrated springs. Then less tension would be quired, resulting in longer belt life.

Belt Shifters are usually of the palm type and these are st satisfactory. Some mills have tried roller shifters th good results in some cases and in others with nearly astrous results. If rollers are used, they should have ple bearing size. The face width should be approxi- tely 10 in. long. The long face is necessary to keep belt from running up and over the end as the belt leflected by pressure from the rollers when the belt shifted. All the author's experience has been with t-faced rollers, however, a concave face could be used. ere will be more maintenance on roller shifters, such oiling and replacing of bearings, than the standard e in use today.

Rider Belts on cone pulleys are being used in a few places to get more belt capacity, however, in the author's opinion rider belts should only be used in emergencies. Moreover, a rider won't work in all cases. Generally, keep the rider tighter, narrower, and lighter than the main belt. An old leather belt or a rubber belt can be used as a rider. A properly designed drive will not need a rider belt.

CONE TAPERS AND BELT WIDTHS

When designing the cone drives for a machine, the horsepower and the percentage of draw for each section of the machine should be worked out, keeping the cone taper $^3/_4$ in. per foot or under. Cone pulley diameters should be selected to give a belt speed up to a maximum of 6000 f.p.m. (preferably less) at the ultimate paper speed. Center distance, load, section of the machine, and space limitations may affect the belt width that can be used.

Different sections of the paper machine have wide variations in power requirements and starting loads. For instance, the couch has a relatively easy starting load, however, its running load is the greatest of any section. It requires a drive with a minimum cone taper and maximum belt width.

The drier sections are usually the most difficult to start due to the great mass of each section. Doctors, tight steam joints, and partially filled driers all add to the starting and running load. Inching of the driers is often necessary and is very hard on clutches and belting. Some sections may require inching motors to carry the terrific starting and crawling load. Plain bearings also add to the starting load.

Yankee driers on tissue machines have a very heavy starting and stopping load that must be considered when designing a belt for this section. Four-ply leather belts may solve the problem if the belt width cannot be increased.

On kraft and board machines, the dry end belts may pull part of the load of the section ahead of it. This is true of the reel, calender, calender drier, and drier sections. It is therefore important not to use a very narrow belt between two wide belts even though the horsepower of the section is low. If a narrow belt is used, it may not pull its share of the load and will act a a brake.

The calender drier drive has a very heavy belt load as it is usually driven from the inshaft to the calender. This makes the belt speed slow and the belt wide for the horsepower.

Paper machine belts should work as a team, each pulling its share of the load. Properly proportioned belts for the load and section of the machine will give

Table I

Machine section	*Belt overload factor f*
Couch	2.1–2.6
Dual press	2.6–3.4
Suction press	2.1–3.4
Drier	2.1–3.4
Yankee drier	2.6–4.0
Breaker stack	2.1–2.6
Size press	2.6–4.0
Smoothing and marking press	2.1–4.0
Coater	2.6–4.0
Calender stack	2.1–3.4
Calender drier	3.4–4.7
Reel	2.6–4.7

maximum machine speed and low cost per ton of paper produced.

BELT WIDTH CALCULATIONS

From experience, the following overload factors should be used to figure belt widths.

A simplified belt width formula for special tanned leather belts is as follows: use heavy triple belting wherever possible (see Table III).

Factor f includes starting overload, vertical drive, cone pulleys, moisture, etc.

$$W = \frac{H \times f}{K} \qquad (1)$$

where

W = belt width in inches
H = section horsepower
f = belt overload factor, Table I
K = belt horsepower per inch of width, Table II

Example: 90 hp. first drier, 5900 f.p.m. belt speed, center distance 14 ft., mean cone pulley diameters:

Table II. Belt Horsepower per Inch of Width, *K*

Belt speed, f.p.m.	*Double-ply, heavy*	*Triple-ply*	
		Medium	*Heavy*
600	2.2	2.5	2.8
800	2.9	3.3	3.6
1000	3.6	4.1	4.5
1200	4.3	4.9	5.4
1400	4.9	5.7	6.3
1600	5.6	6.5	7.1
1800	6.2	7.3	8.0
2000	6.9	8.1	8.9
2200	7.6	8.8	9.7
2400	8.2	9.5	10.5
2600	8.9	10.3	11.4
2800	9.5	11.0	12.1
3000	10.0	11.6	12.8
3200	10.6	12.3	13.5
3400	11.2	12.9	14.2
3600	11.7	13.4	14.8
3800	12.2	14.0	15.4
4000	12.6	14.5	16.0
4200	13.0	15.0	16.5
4400	13.4	15.4	16.9
4600	13.8	15.8	17.4
4800	14.1	17.2	17.8
5000	14.3	16.5	18.2
5200	14.6	16.8	18.5
5400	14.8	17.1	18.8
5600	15.0	17.3	19.0
5800	15.1	17.5	19.2
6000	15.2	17.6	19.3

Four-ply belts have 25% more horsepower capacity than triple-ply.

38-in. driver, 37-in. driven, face width 42-in., $^3/_8$-in. cone taper per foot on the diameter. Plain bearings.

Try heavy triple belt as follows:

$$W = \frac{90 \times 2.5}{19.2} = 11.75 \text{ in. use 12-in. heavy triple-ply special tanned belt}$$

$$W = \frac{90 \times 3.4}{19.2} = 16\text{-in. maximum heavy triple-ply special tanned belt}$$

The next step is to determine whether the belt width calculated is within the limits of good face width contact for the given cone taper. Actually, very little information has been published regarding this relationship between cone taper and belt width. Both the formulas and graph were developed from the author's experience. They are based on a minimum center distance of 12 ft. and an average cone diameter of 36 in.

$$W_r = \frac{6}{T} = T = \frac{T}{W_r} \qquad (2)$$

$$W_m = \frac{7.5}{T} = T = \frac{7.5}{W_m} \qquad (3)$$

where

W_r = recommended belt width
W_m = maximum belt width
T = cone taper in inches per foot of pulling face on the diameter

Checking the drier drive example $W = 7.5/\ 0.375 =$ 20-in. maximum belt recommended for the cone taper. Any calculated belt width equal to or less than this will be satisfactory. A 12-in. belt is recommended for the load and the 42-in. face cones unless the starting conditions are extremely severe or experience has shown that a wider belt is required.

Table III. Minimum Pulley Diameters
Special Tanned Leather Belt

	Up to 2500 f.p.m.	*2500–4000 f.p.m.*	*4000–6000 f.p.m.*
Heavy double[a]	6	7	8
Medium triple[b]	14	16	18
Heavy triple[b]	18	20	22
Medium four-ply[b]	26	28	30
Heavy four-ply[b]	30	32	34

a For belts 8 in. and over add 2 in. to minimum pulley diameter shown.
b For belts 8 in. and over add 4 in. to minimum pulley diameter shown.

Center distance, cone diameters, load, and atmospheric conditions all influence the selection of a belt for a given machine section. Formula (1) will be correct for most of the drives calculated and by staying within the maximum limits, good face width contact and maximum power transmission are assured. Occasionally it may

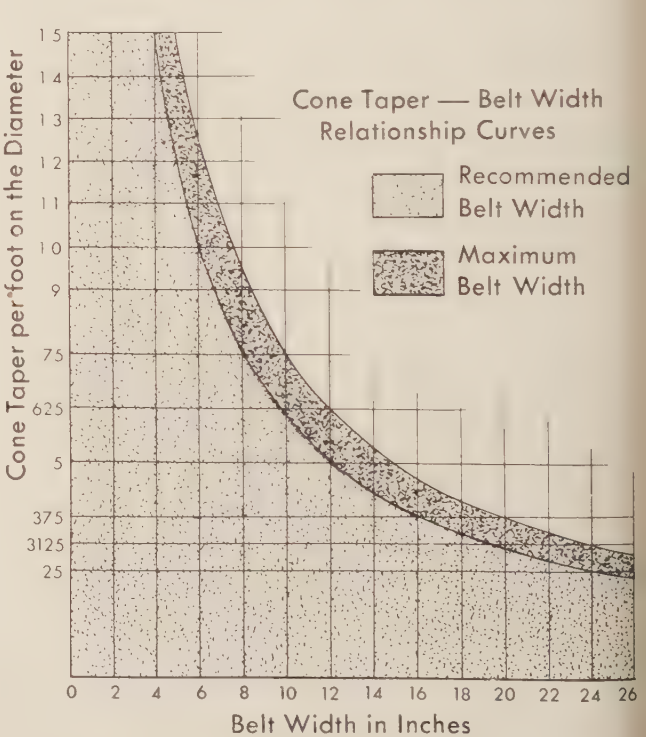

Fig. 1

e necessary to go over the maximum width recom-ended to handle the starting and running load. onger centers and larger diameter cones often make is possible.

HELPFUL HINTS FOR COMMON DIFFICULTIES

When a belt rubs the shifter shoe hard, check align-ent, check both cones to see if the tapers are identical, eck the tension at both edges of the belt, check belt nsion—if slack, tighten it.

When a belt rubs the shifter shoe toward the low end the cone on a couch belt drive with a helper motor in rallel with the belt, try giving the belt more work to by cutting down the load on the helper motor. ghten the belt.

When paper breakage at one section of the machine curs quite often, check all clutches to make sure they e not slipping, check the belt tension while running d when stopped. If it is a high-speed belt (5800 p.m.), it may appear loose when running but tight hen stopped. If it won't pull the load, tighten it. ossibly a wider belt should be used. Sometimes a rrower and heavier belt with more tension than usual ill do the trick.

When a belt won't carry the load, check the belt apacity with formula (1), check tension and surface of elt; if dry, dress it, check the total percentage of tretch since installation. If excessive (8% or over), he belt is probably too small or the belt may be worn ut. If tightening doesn't help, try a wider belt or eavier. Try four-ply if belt speed is under 4500 f.p.m. nd pulley diameters are 38 in. or over. If the taper is eavy and could stand being reduced and still maintain the desired draw, reduce the taper and the same belt will probably pull the load satisfactorily.

Can crossed belts be used? Yes, but they are often troublesome because one edge of the belt must be longer than the other. Long center distance and a belt narrow as possible for the load will give best results.

When the drier belt can't be kept tight, check the taper on driver and driven cones. If they are different, make them the same. Check belt capacity. Check all bearings on this section and for tight steam joints. The belt may not be large enough for the load: try a wider belt.

When the calender drier belt is slack on the bottom when it should be on top, the belt is too small. Make it wider so it will pull rather than act like a brake.

When the edges of a couch belt buckle under every time the belt makes a trip around the pulleys, the belt is probably too wide for the cone taper, center distance, and pulley diameters in use. Check the belt width with formulas (2) and (3). Try cutting the belt width down 2 in. This will probably solve the problem.

CONCLUSION

The paper machine that is driven by well-designed drives and suitable belts for each section is an efficient and economical machine. In comparison with other drives it is relatively easy to operate and maintain. Belt-driven machines today are turning in excellent performance records. As proof of this, it is a belt-driven, high-speed fourdrinier machine that holds the record for tons of paper produced in a 24-hr. period. That certainly is a good indication that a belt-driven machine is an excellent high-production machine.

The Effect of Packing Type on the Rate of Black Liquor Oxidation

R. H. WRIGHT

An experimental method of testing oxidation tower packing materials is described which has a number of important advantages. It uses actual tower packing material rather than a scaled-down approximation to it. By recycling the black liquor the behavior of a column of full height is approximated. Simple mathematical relations lead directly to values for the area of packing required, the tower height, and the feed rate. It is shown that vertical sheets bearing a suitable surface pattern possess significant advantages in improved oxidizing effectiveness combined with absence of foaming.

In a previous communication (*1*) it was shown that the oxidation of sulphate black liquor by air requires a limiting exposure time of about 3 min. when the exposed surface is very large. It follows that measures to obtain extremely large surface areas, for example by foaming, are unnecessary and may cause difficulty with species of wood which give unusually stable foams. Under the circumstances it seems preferable to focus attention on a type of oxidation unit in which a large area of contact between liquor and air can be obtained without foaming and maintained for the necessary time.

Accordingly, the oxidation process was studied with black liquor flowing down vertical sheets which had been given a surface imprint intended to retard the rate of flow and so increase the contact time, while avoiding any tendency to foam.

EXPERIMENTAL METHOD

The apparatus used is shown in Fig. 1. A box made of Lucite plastic measuring 36 in. long by 3 in. wide and 4 in. deep was mounted vertically. A strip of packing to be tested was supported inside the box with its lower end in a funnel. The black liquor leaving the strip passed from the funnel to a small centrifugal pump which returned it to the top of the sheet. The return

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tube was heated with chromel resistance wire to maintain the liquor at a constant temperature. A simple type of orifice meter enabled the flow rate to be measured. The flow rate was controlled manually by a Variac connected to the pump. Thus, a given quantity of black liquor could be circulated continuously and at a known rate over the surface of a test strip of known height and surface area.

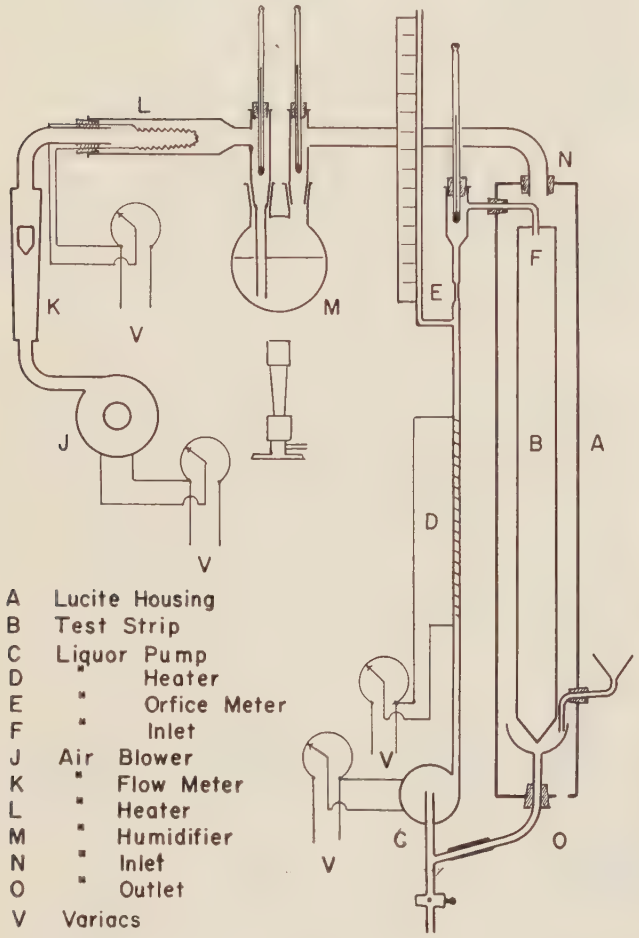

Fig. 1

The liquor passing down the test strip was exposed to a concurrent stream of air blown into the top of the box. The air was preheated and humidified so as to simulate conditions inside an oxidation unit where warming of the air and evaporation of water take place only in a small region close to the air inlet. The air was made to flow concurrently so that malodorous material which might be liberated from the fresh black liquor entering a full-scale apparatus and taken up by the air stream would be reabsorbed and fixed in the oxidized black liquor farther along.

No attempt was made to simulate the change in oxygen content of the air which would take place in a full-sized unit. This would be a second-order effect provided a reasonably large ratio of air to black liquor were maintained.

The course of the oxidation reaction was followed by withdrawing small ($^1/_8$-ml.) samples of black liquor by means of a hypodermic syringe and needle inserted through a short piece of rubber tubing connected in the return circuit next to the pump. The black liquor was analyzed colorimetrically for Na_2S by a method described elsewhere (*2*).

The test strips were usually 2 in. wide and were wetted over a length of 32 in. They were generally made of asbestos-cement or wood with a surface pattern impressed or cut with a saw. Some of the patterns tested are shown in Figs. 2 and 3. Those to which particular attention is drawn are the "diamond pattern," Fig. 2, left, the "cloth imprint," Fig. 2, center, and the "washboard," Fig. 3, left.

Table I. Effect of Surface Configuration on Oxidation Time

Feed Rate, 125 Lb. per Hr. on 2-In. Strip

Run	*Surface*	*Temp., °C.*	*Black liquor, lb.*	*Oxidation time, min., when Na_2S content is: 1 g./l.*	*2 g./l.*	*4 g./l.*
4V	Smooth	65	0.309	4.81	6.20	7.70
6V	Cloth imprint	65	0.336	4.04	5.25	6.47
14V	Washboard	67	0.354	3.32	4.32	5.32
24V	Diamond	70	0.354	2.42	3.15	3.88

The black liquor used in the experiments was collected at the Bloedel Stewart and Welch Pulp Mill at Port Alberni, B. C., and shipped to the laboratory in

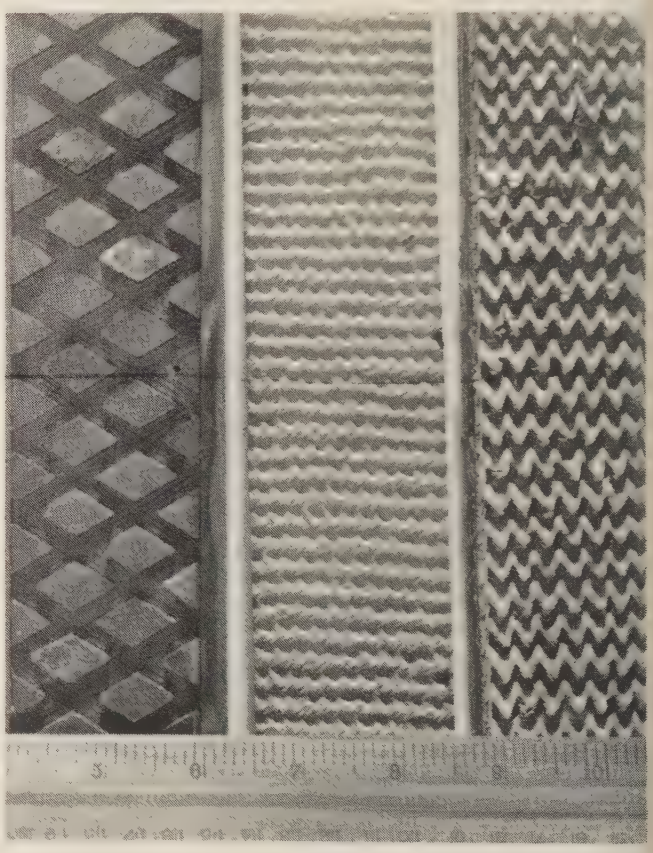

Fig. 2

sealed Winchester bottles. Two batches were used, one from a cook of western hemlock and one from a cook of western red cedar, using a white liquor of approximately 17.5% sulphidity.

The procedure in making a run was as follows: A measured volume of fresh black liquor was removed

om the stock bottle by displacement with nitrogen id quickly warmed to about 80°C. in a stoppered sk. It was then transferred rapidly to the oxidation paratus through a funnel and delivery tube leading the collecting funnel at the bottom. At the same ne the circulating pump was started. As the liquor gan to flow down the test strip a stop watch was arted and, samples were taken for analysis at half-inute intervals beginning 15 sec. after the commence-nt of flow.

RESULTS

The black liquor had a rather low sodium sulphide ntent. In order to estimate the probable course of ents with black liquor containing larger amounts, the ncentration of Na_2S was plotted against time and a ooth curve was drawn through the points. From s preliminary curve the time required for the Na_2S ntent to fall from 1 to 0.5 gram per liter was picked f and a "first-order rate constant" was determined m the formula

$$K = \frac{\log 2}{t_{1/2}}$$

Assuming the reaction to be first order, a curve of

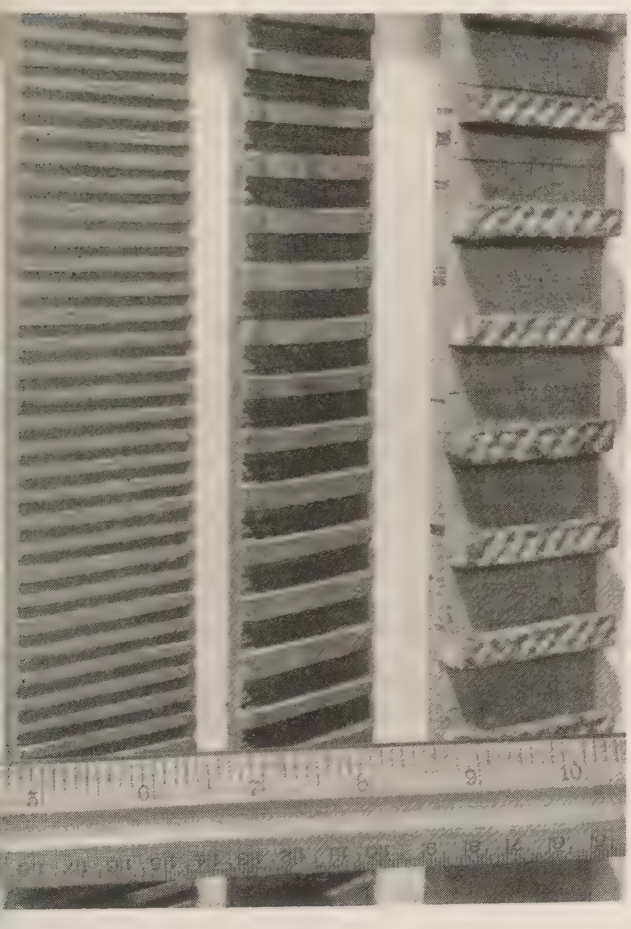

Fig. 3

a_2S concentration versus time was computed using the ove rate constant and plotted to coincide with the eliminary experimental curve at $C = 1.0$ gram per er. Figure 4 shows the agreement obtained between e computed curves and the experimental points.

Since the time for a first-order reaction to reach completion is theoretically infinite, it was arbitrarily assumed that the black liquor was fully oxidized when its Na_2S content was reduced to 0.1 gram per liter. By taking from the calculated curves the time required for the Na_2S content to fall from any given initial value to a final value of 0.1 gram per liter reaction times like those shown in Table I were obtained.

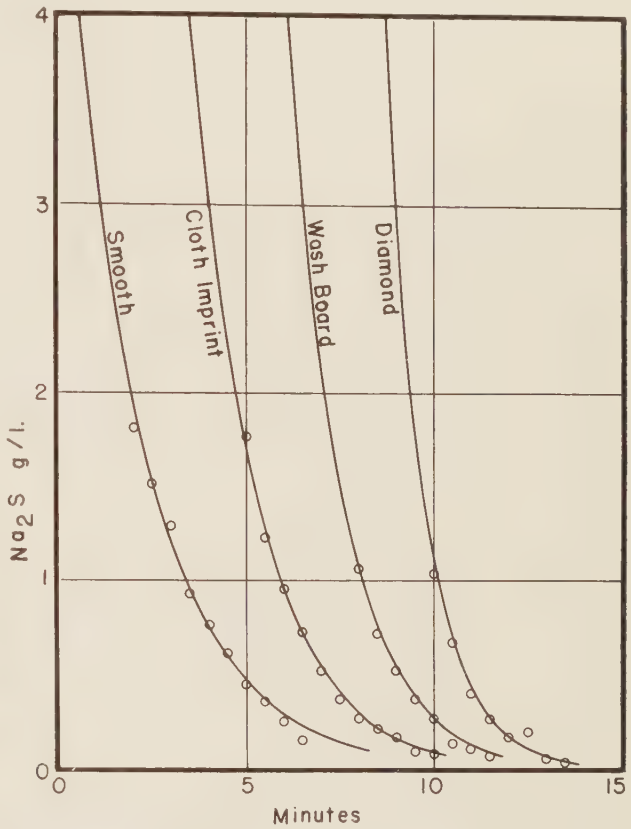

Fig. 4

Experiments were carried out at various flow rates and temperatures and using various surface configurations. The results were expressed in terms of a "surface effectiveness" which was the number of pounds of black liquor oxidized per hour per square foot of surface. Table II shows some values calculated from the data in Table I.

Table II. Surface Effectiveness for Various Surface Patterns

	Pounds black liquor oxidized per hour per square foot when Na_2S content is:		
Surface	*1 g./l.*	*2 g./l.*	*4 g./l.*
Smooth	8.6	6.7	5.4
Cloth imprint	11.2	8.6	7.0
Washboard	14.4	11.1	9.0
Diamond	19.7	15.2	12.3

It is immediately apparent that the surface configuration of the sheets is very important. This follows from the fact that a finite time is required for the reaction. The ratio of holdup to throughput has the dimensions of time and is, in fact, the residence time of the black liquor on the plate. A suitable surface configuration will increase the holdup and hence the contact time although this cannot be carried too far without reducing

the specific surface to a point where the resistance of the air-liquid interface becomes important.

It was found that over a considerable range, the effectiveness of a given surface configuration was almost independent of the feed rate. Very high feed rates caused flooding and foaming, and very low values gave incomplete plate coverage. The exact values for these limits depend on the surface configuration.

DISCUSSION

Based on these results, a preliminary estimate of the over-all dimensions of an oxidation unit can be made.

Let E_n denote the number of pounds of black liquor (containing n grams per liter of Na_2S) oxidized per hour per square foot of plate. E_n may be called the "surface effectiveness." It is assumed to be constant from top to bottom of the sheet and to be independent of the feed rate.

Let F denote the rate of feed of black liquor to a plate, divided by the horizontal width of the plate. F may be called the "feed density" and is expressed in pounds of black liquor fed per hour per foot of leading edge.

Let Q denote the total quantity of black liquor to be oxidized, expressed in pounds per hour.

The total area of plate surface S required is then given by

$$S = \frac{Q}{E_n} \text{ sq. ft.}$$

and the total length of leading edge, G, is given by

$$G = \frac{Q}{F} \text{ ft.}$$

The height of the plates is,

$$H = \frac{S}{G} = \frac{F}{E_n} \text{ ft.}$$

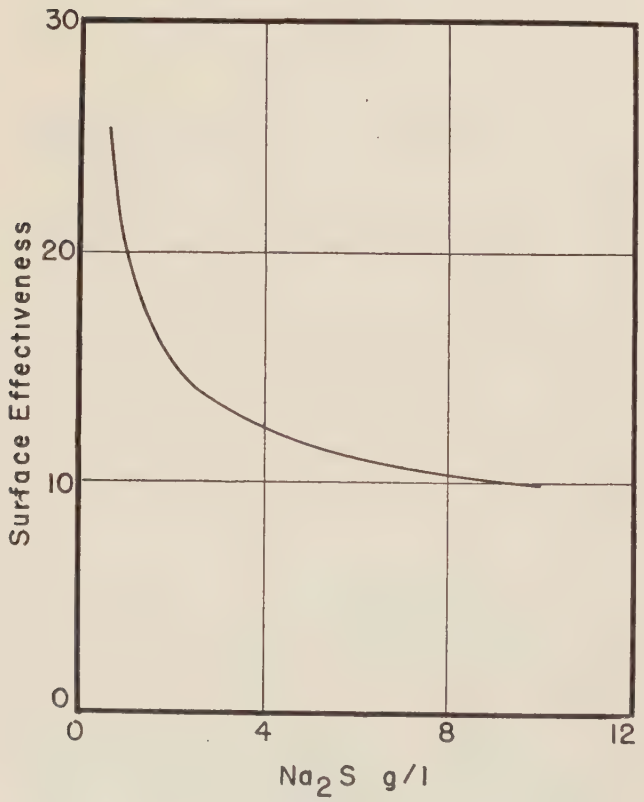

Fig. 5

In order to estimate the cross-sectional area of the unit, it is necessary to assume a particular mode of packing and a corresponding figure for the number of linear feet of leading edge per square foot of cross section. For example, if the packing consists of thin vertical flat sheets on 1-in. centers and if both sides of the sheets are wetted, then the packing will afford 24 ft. of leading edge per square foot of cross section. In order to provide G feet of leading edge the unit should have a cross-sectioned area of

$$A = \frac{G}{24} = \frac{Q}{24F} \text{ sq. ft.}$$

From these equations it follows that within the limits imposed by foaming on the high flow side and poor liquor distribution on the low flow side, the oxidation unit can be given any desired ratio of height to cross section, subject to a small, second-order, correction due to the variation of surface effectiveness with feed density.

Table III shows the estimated tower dimensions for a unit to oxidize 200,000 lb. per hr. of black liquor containing 4 grams per liter of Na_2S, assuming a surface efficiency of 12 lb. per hr. per sq. ft.

Table III. Estimated Tower Dimensions for the Oxidation of 200,000 Lb. of Black Liquor per Hour

$n = 4$ g./l.; $E_n = 12$ lb./hr./sq. ft.

Feed density, lb./hr./ft.	*Cross section, sq. ft.*	*Height, ft.*
200	41.7	16.7
300	27.8	25.0
400	20.8	33.3
500	16.7	41.6
600	13.9	50.0
700	11.9	58.3
800	10.4	66.6

Figure 5 shows how the surface effectiveness of a plate bearing the diamond imprint may be expected to vary with the sodium sulphide content of the black liquor. From this it is apparent that for higher Na_2S contents a very much less than proportional increase in tower dimensions is required.

It is interesting to estimate the total area of the packing sheets required for a typical unit. Using the same constants as before, the total surface S is given by

$$S = \frac{Q}{E_n} = \frac{200{,}000}{12} = 16{,}700 \text{ sq. ft.}$$

If the sheets are wetted on both sides, approximately 8400 sq. ft. of packing sheets are required. It follows that a very compact oxidation unit can be constructed. (See Table III.) Moreover, by using vertical parallel sheets, suitably spaced, resistance to air flow can be made small and the power requirements for the circulating fans are correspondingly reduced.

Froth formation was entirely absent with all the strips tested except that shown in Fig. 3, right.

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nterrelationships of Temperature, Pressure, and Pressing Time in the Production of Hardboard from Douglas-Fir Fiber

The Effects of these Variables on Hardboard Properties

HUGH WILCOX

he selection of proper pressing conditions is essential to e production of hardboards of high quality and uniform perties. Temperature and pressure affect the proessive temperature rise at the midthickness of the fiberard mat, and the final density and modulus of rupture the hardboard. Study of the temperature-time curve ll aid in the formulation of a three-stage pressing cycle hich will shorten pressing time, and regulate density d modulus of rupture. A study of hardboards of equal nsity indicates that strength increases in direct corretion with increases in pressing temperature from 340 460°F. Further progressive increases in strength occur hen boards are held in the press up to an hour after they ave reached platen temperatures of 340 to 400°F. Those eld at 460°F. show a progressive decrease in strength.

THIS paper is a report of studies made at the regon Forest Products Laboratory on the hot-pressing hardboard from Douglas-fir fiber processed in a auer mill. The studies were designed primarily to etermine the effects of the variables in a three-stage ressing cycle on the physical properties of the resultnt board.

The three-stage pressing cycle is commonly used in ndustry and consists of a brief initial press or squeeze high pressure, a pressure release (known as a "breathg-cycle") to allow the release of steam from the at, and a second pressure period that is maintained ntil the board is dry.

With the knowledge acquired from the above studies, oards of a like specific gravity were made at each of ree platen temperatures. The effect of these pressing mperatures on board properties was studied, as well s the effect of maintaining the final temperature for arious periods of time.

LITERATURE

The U. S. Forest Products Laboratory has studied rdboards made from both old-growth and secondowth Douglas-fir fiber, attrition-milled in the Bauer ilper. Schwartz, Pew, and Schafer (*1*) of that labratory investigated the properties of insulating boards nd hardboards produced from coarse-fibered pulps hich had undergone various cooking and milling rocedures. These investigators used a definite threeage pressing cycle throughout their experiments and ublished the pressure ranges but not the platen temeratures used.

Turner, Hohf, and Schwartz (*3*) prepared hardboards from raw, second-growth Douglas-fir fiber milled in the Bauer. Many of the manufacturing variables involved in the conversion of the wood to fiberboard were investigated and presented in the form of curves. Some of these curves show time-temperature relationships at different pressures, the temperatures being taken at the center of the board; others show the total pressing time as a function of platen temperature at various pressures.

Schwartz and Baird (*2*) reported that Douglas-fir hardboard prepared from pulps produced by fiberizing water-soaked chips can be dried and heat treated in one short operation in a hot press at temperatures in excess of 200°C. These hardboards have higher moduli of rupture and better dimensional stability than those produced at lower temperatures.

EXPERIMENTAL

Half-inch chips were prepared from old-growth Douglas-fir slabs and edgings. The chips were steamed for 45 min. at 45 p.s.i. steam pressure in a 40-gal. tumbling digester and then fiberized in a 24-in., double-disk Bauer mill using B-1692-93 plates run in a direction to produce a brushing action on the fiber. For most of the tests, a coarse fiber was prepared by using a 0.010-in. plate setting. This produced a free pulp that was less likely to blow out under high temperatures and pressures during the pressing operation.

The wet mats were prepared in a 24 by 24-in. suction mold using a pulp consistency of about 0.5%, cold-pressed to remove excess water, and then sawed into quarters. The resultant 12 by 12-in. mats were stored at 35°F. until ready for hot-pressing.

Each mat was placed on a screen and pressed between stainless steel cauls in a 150-ton capacity press with 24 by 24-in. steam-heated platens. Time-temperature data were obtained at the center of each mat by drilling a hole in the mat and inserting a thermocouple. Initially, the platen temperatures and pressing pressures were kept constant throughout each pressing cycle in order to obtain an easily reproducible time-temperature curve for duplicate samples. Boards were pressed at platen temperatures of 280, 340, 400, and 460°F., and at pressures of 200, 500, and 1000 p.s.i. The results are plotted in Figs. 1 and 2.

Time-temperature relationships at midthickness of hardboards also were studied during press drying at several platen temperatures, using schedules employing

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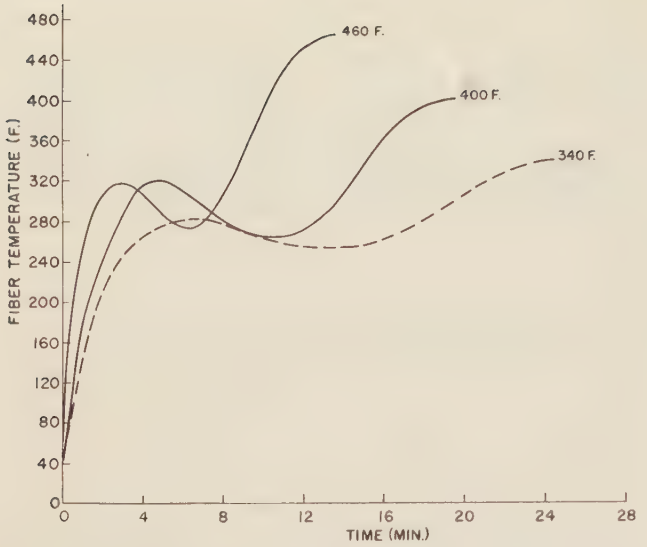

Fig. 1. Time-temperature relationship at midthickness of Douglas-fir hardboards during press-drying at several platen temperatures at a constant pressure of 215 p.s.i.

a high initial squeeze and a breathing cycle. Different pressures and holding times for the initial squeeze, different lengths of breathing cycles, and different final pressures were used; their effects on the time-temperature curves and on the physical properties of the board were determined. Duplicate boards were made for each variation.

Modulus of rupture, specific gravity, and water absorption and swelling after 24-hr. immersion were determined for all hardboards. The flexural tests were made with 3-in. strips on an 8-in. span with a head speed of 4 in. per min.

RESULTS

Figure 1 shows temperature-time curves for hardboards that were press-dried at different platen temperatures but a constant pressure of 215 p.s.i. Figure 2 shows a similar series of temperature-time curves for hardboards pressed at different pressures but a constant temperature of 400°F. All these curves have the same general shape: a steep initial rise in temperature, followed by a sharp, but smaller, decline; then a constant temperature period until the water is completely gone; finally, a temperature rise until the end of the pressing cycle. Elevated temperatures and pressures decrease drying time, but a practical limit is set by the danger of generating superheated steam in the mat, with the possibility of a blowout and a resultant decrease in fiber strength.

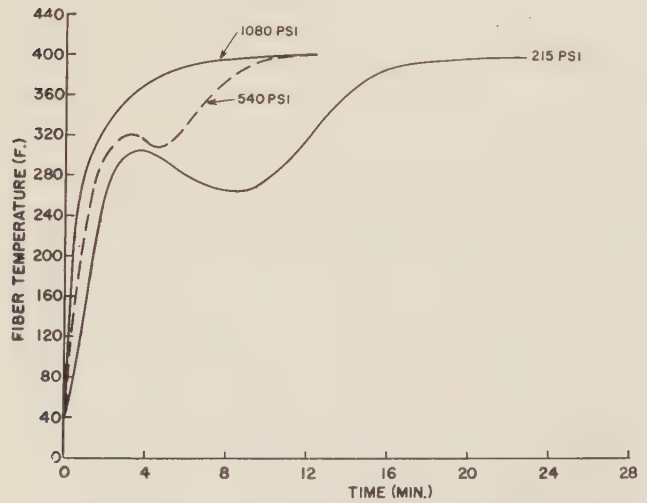

Fig. 2. Time-temperature relationship at midthickness of Douglas-fir hardboards during press-drying at several pressures and a constant platen temperature of 400°F.

The steepness of the initial rise in temperature and the length of the constant-temperature period are definitely functions of both pressure and platen temperature. The slope of the final rise in temperature varies with the platen temperature but appears to be independent of the pressure.

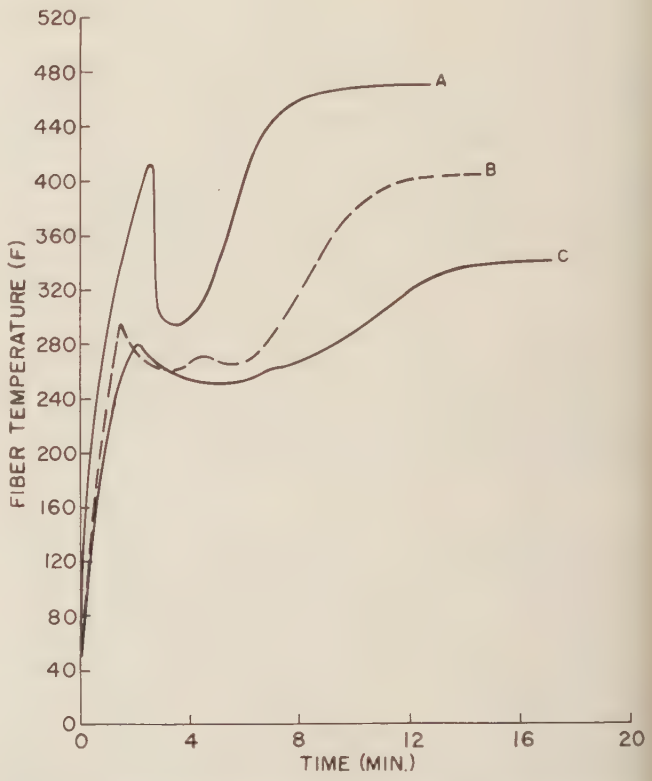

Fig. 3. Time-temperature relationship at midthickness of hardboards during press-drying at several platen temperatures, using schedules employing a high initial squeeze and a breathing cycle

A: 2 min. at 1000 p.s.i.; 2 min. breather; holding pressure 200 p.s.i., 460°F. B: 1 min. at 1000 p.s.i.; 2 min. breather; holding pressure 200 p.s.i.; 400°F. C: 2 min. at 1000 p.s.i.; 4 min. breather; holding pressure 200 p.s.i.; 340°F.

Figures 3, 4, and 5 show the modifications in the time-temperature curves caused by the introduction of a breathing cycle immediately following an initial squeeze at high pressure. A comparison of Fig. 3 with Fig. 1 shows that a high pressure during the initial squeeze significantly decreases the time required to reach platen temperature. The initial temperature rise of the mat is strikingly high and rapid at high platen temperature and pressure. An initial pressure of 1000 p.s.i. at 470°F. can be maintained for 2 min. without blowouts, but this represents about the maximum limits of time, temperature, and pressure. A uniform temperature rise during the final holding pressure indicates that the breathing cycle was long enough to dry the mat completely. The presence of residual moisture is indicated by a secondary maximum and minimum in the final rise of the curve. If the initial squeeze and breathing cycle are both too

short, the hump in the last portion of the time-temperature curve is conspicuous, and the surface of the board is strongly water-marked. A comparison of Figs. 2 and 4 shows that the breathing cycle does not appreciably shorten the pressing time. It is the initial squeeze that is instrumental in shortening the pressing cycle, the breathing cycle merely preventing a blowout. Figure 4 shows that neither a 2 nor a 4-min. breather is long enough to dry the mats before the final pressure is applied. Actually, it is undesirable to have a completely dry fiberboard mat before the final pressure is applied, because the presence of moisture in the mat during the final pressure cycle is necessary to obtain high specific gravity and flexural strength.

Figure 5 also shows to what extent a high-pressure initial squeeze shortens the pressing schedule. Further-

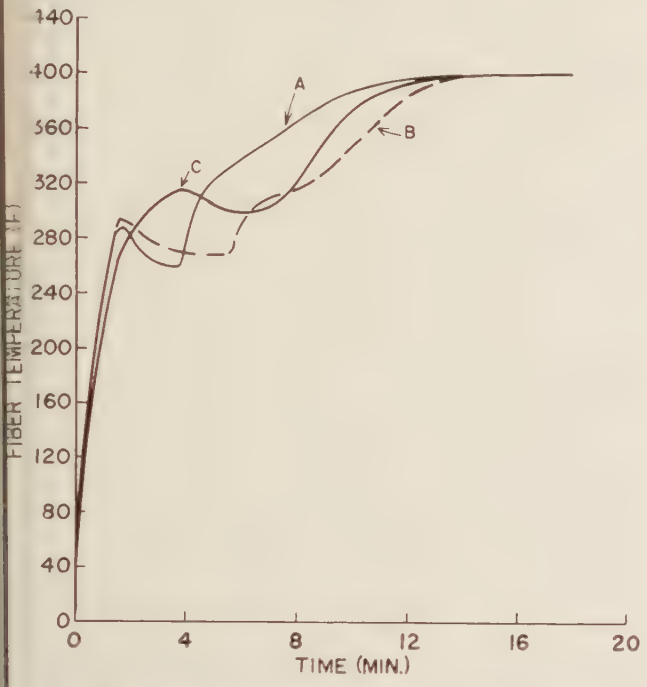

Fig. 4. Time-temperature relationship at midthickness of hardboards during press-drying at 400°F. showing effect of varying time of breathing

A: 1 min. initial squeeze at 1000 p.s.i.; 2 min. breather; holding pressure 500 p.s.i. B: 1 min. initial squeeze at 1000 p.s.i.; 4 min. breather; holding pressure 500 p.s.i. C: 500 p.s.i. throughout.

more, it demonstrates that the slope of the final temperature rise is determined by the platen temperature and is virtually independent of platen pressure.

Figure 6 shows the effect, at a constant pressing temperature, of initial squeeze time and breathing time on the specific gravity of the hardboard. The initial squeeze pressure was 1000 p.s.i. and the final pressure 500 p.s.i. for the series of boards pressed at 340°F. When a $^1/_4$-min. squeeze was used, some water remained regardless of the length of the breathing time. Although enough moisture was present in the final pressure period to give specific gravities above 1.0, the squeeze time was too short to shorten the pressing schedule materially. The $^1/_2$-min. squeeze, with breathing periods of up to 4 min., yielded boards with specific gravities above 1.0, but the specific gravity dropped sharply when longer breathing cycles were used. Following longer initial squeezes, the breathing cycle had to be shortened still more to maintain a high spe-

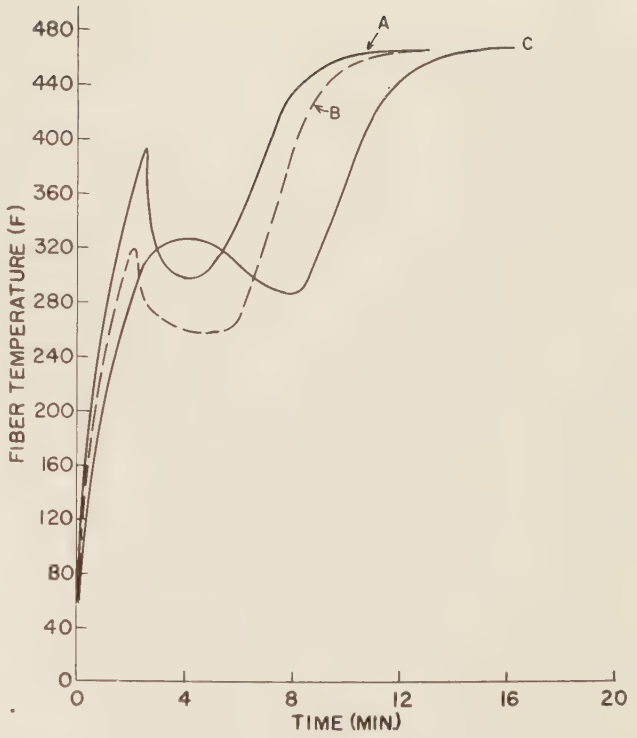

Fig. 5. Time-temperature relationship at midthickness of hardboards during press-drying at 470°F. showing effects of varying initial squeeze pressure

A: 2 min. initial squeeze at 1000 p.s.i.; 3 min. breather; holding pressure at 1000 p.s.i. B: 2 min. initial squeeze at 500 p.s.i.; 4 min. breather; holding pressure at 200 p.s.i.; C: 200 p.s.i throughout.

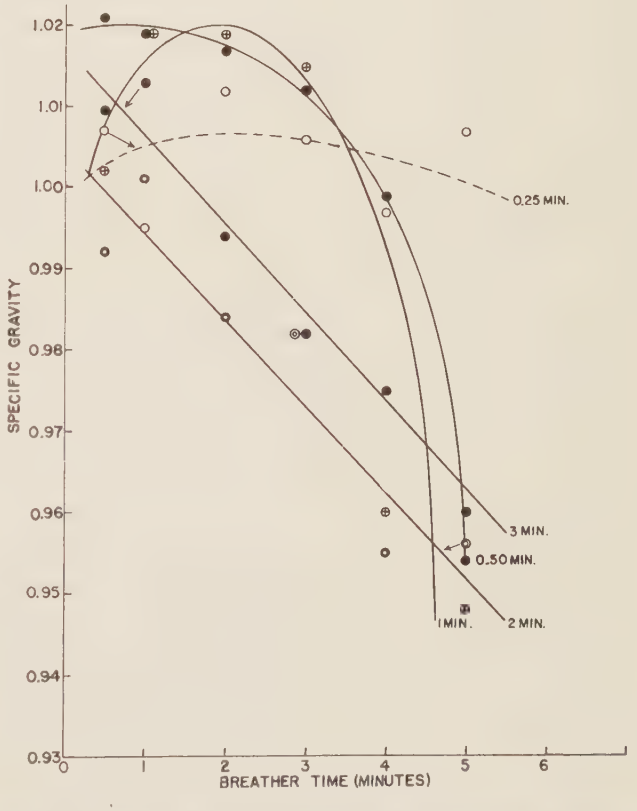

Fig. 6. The effect of breathing time on the specific gravity of hardboard pressed with various times of initial squeeze at 1000 p.s.i.

Pressing temperature maintained at 340°F. and final pressure kept at 500 p.s.i. until platen temperature was reached.

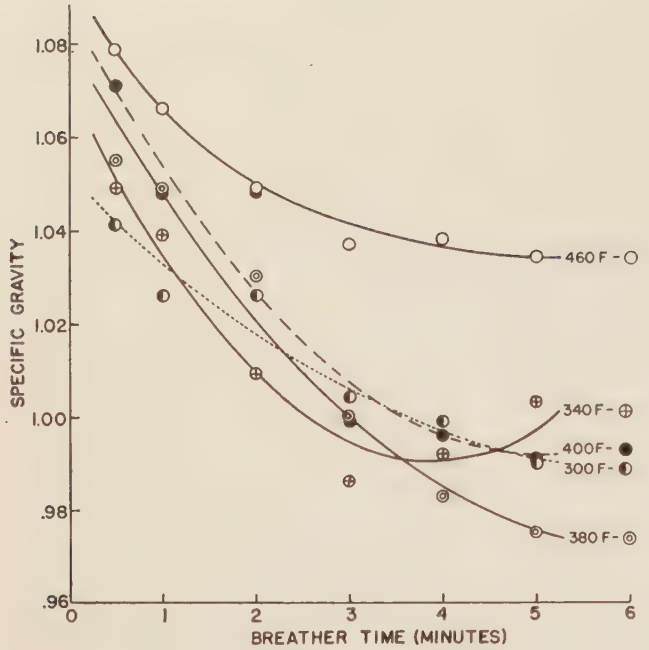

Fig. 7. The effect of breathing time on specific gravity of hardboards pressed at various temperatures

Initial squeeze maintained at 1000 p.s.i. for 2 min. and final pressure at 500 p.s.i. until platen temperature was reached.

cific gravity. An inversion occurred between the 2 and 3-min. initial squeezes, a lower specific gravity being obtained with a given breather for a 2-min. squeeze than for a 3-min. one. This phenomenon was encountered repeatedly, but cannot be explained. The data from tests using the 3-min. initial squeeze displayed the closest approach to a linear relation between specific gravity and breathing time. The 3-min. squeeze also had the economic advantage of shortening the total pressing time by the greatest amount.

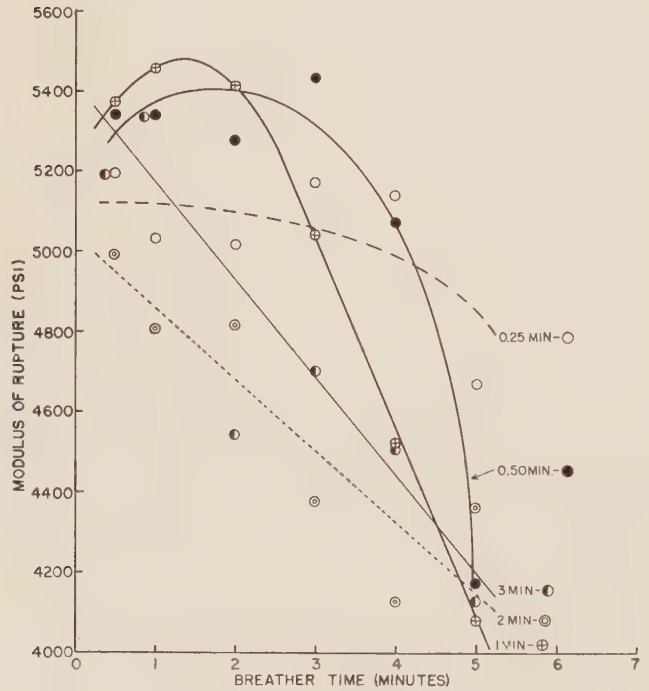

Fig. 8. The effect of breathing time on the modulus of rupture of hardboard pressed with various times of initial squeeze at 1000 p.s.i.

Pressing temperature maintained at 340°F. and final pressure kept at 500 p.s.i. until platen temperature reached.

Figure 7 shows the effect of breathing time on the specific gravity of hardboards pressed at various temperatures. An initial squeeze of 1000 p.s.i. for 2 min. and a final pressure of 500 p.s.i. were used in each case. These curves cover a wider specific gravity range than those in Fig. 6, indicating that temperature is of relatively greater importance in determining specific gravity than is the initial squeeze time. At 300 and 460°F., with a 2-min. initial squeeze at 1000 p.s.i., increased length of breathing time is less effective in decreasing specific gravity than at the intermediate temperatures. The curves in Figs. 6 and 7 show clearly that accurate control of the pressing cycle is essential to maintaining a uniform specific gravity of the hardboard product. Higher temperatures are effective in producing denser hardboards but, at any given temperature, there will be a considerable fluctuation in specific gravity unless the length of the inital squeeze

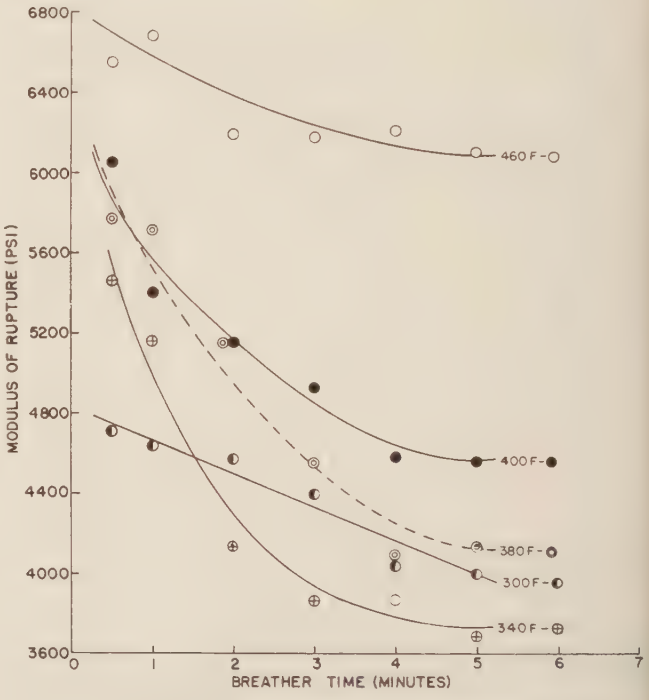

Fig. 9. The effect of breathing time on modulus of rupture of hardboards pressed at various temperatures

Initial squeeze maintained at 1000 p.s.i. for 2 min., and final pressure at 500 p.s.i. until platen temperature was reached.

time and of the breathing period are closely controlled. The initial squeeze should be maintained long enough to shorten the pressing schedule, but not long enough to cause a blowout. The breathing cycle, on the other hand, should be long enough to permit the exit of enough steam to prevent water-marking, but not long enough to reduce seriously the specific gravity of the finished board.

Figures 8 and 9 present the modulus of rupture curves for the same specimens represented in Figs. 6 and 7, respectively. The modulus of rupture curves have the same general shape as the specific gravity curves because of the relationship between these two physical properties. Therefore, the above conclusions could have been derived equally well from either set of curves.

The results portrayed in Figs. 6 and 7 make it possible to select pressing cycles at various platen tem-

eratures that will produce boards with the same pecific gravity. It was thus decided to control the pecific gravity to ascertain whether variations in ressing temperature had any effect on the physical roperties. Boards were prepared at three different mperatures, and breathing schedules were controlled give boards of the same specific gravity. In order study further the effects of tempering, boards were ld in the press from 0 to 60 min. after reaching platen mperature. Figure 10 shows the effect of press-olding time on the modulus of rupture of hardboards essed at 340, 400, and 460°F. It will be noted that rength increases with pressing temperature through-t the range investigated. However, while the strength creases progressively at holding temperatures of 0 and 400°F., it decreases at 460°F, which is prob-bly due to degradation of the cellulose itself.

Figures 11 and 12 show the percentage water ab-rption and swelling in thickness of the hardboard mples from Fig. 10 after 24-hr. water immersion. will be noted that there is a progressive decrease in

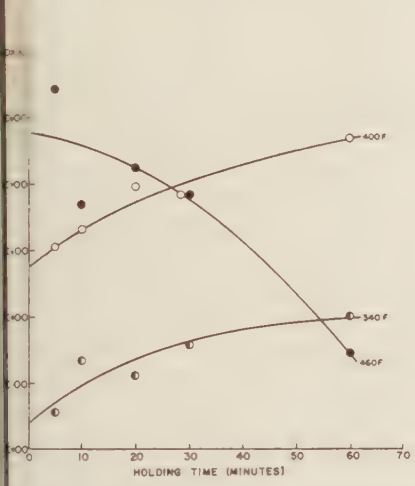

Fig. 10. The effect of press-holding time on the modulus of rupture of hardboards pressed at various temperatures

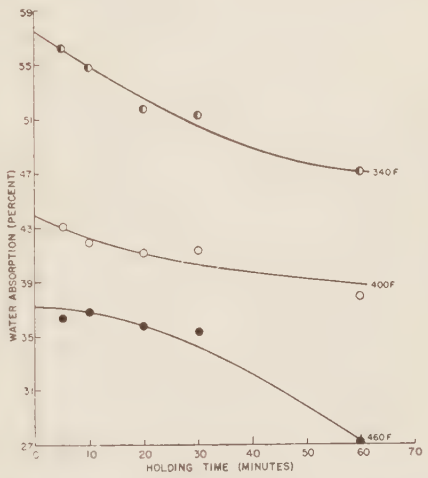

Fig. 11. The effect of press-holding time on the 24-hr water absorption of hardboards pressed at various temperatures.

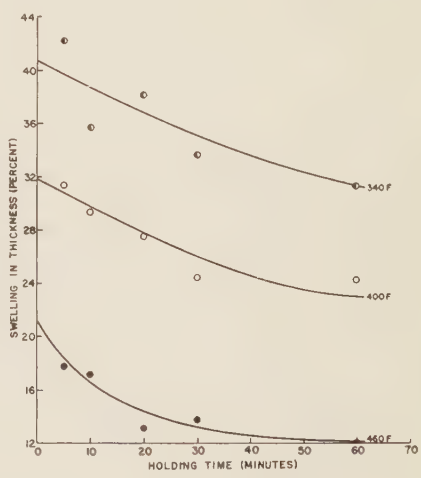

Fig. 12. The effect of press-holding time on the thickness swelling of hardboards pressed at various temperatures

th water absorption and swelling with an increase temperature, and with an increase in time at a con-nt temperature.

DISCUSSION

The selection of a proper pressing cycle is rendered ficult by the complex interrelationships between essing conditions and properties of the resultant rdboard. The data presented in the foregoing curves y be of some assistance in formulating pressing cles to produce hardboards with uniform properties. A study of Figs. 3 and 9 reveals that an increase in essing temperature performs the dual role of shorten-; the pressing cycle and increasing the modulus of ture values. The pressing cycle is shortened about min. for each 20°F. rise in temperature in the ge 340 to 460°F. The modulus of rupture is in-ased about 50% by pressing at 460°F. instead of at 0°F. This increase in strength is only partly due to increase in specific gravity, because the specific vity is increased only 4% by the temperature in-ase in this range.

In view of these temperature effects, the chosen pressing temperature should be as high as possible to obtain the shortest pressing cycle and the maximum modulus of rupture without blowout. At any given temperature, the time and magnitude of the initial squeeze pressure should be chosen to give the desired specific gravity and the shortest possible pressing time. The length of time that the initial squeeze pressure can be maintained varies inversely with the magnitude of the squeeze pressure and the temperature. Usually, the danger of blowout is not incurred because it is impossible to hold the initial squeeze this long without lowering the final specific gravity.

After the squeeze conditions are chosen, a breathing time should be selected that is long enough to allow the escape of steam and prevent blowouts, but not long enough to allow the board to dry in an uncompressed condition, which would lower the specific gravity. The length of the breather has little effect on the length of the pressing cycle. The proper length of the breathing cycle varies inversely with the time and temperature of the initial squeeze. After an initial squeeze from $^1/_4$ to 1 min., a breathing period up to 3 min. can be maintained without seriously reducing the specific gravity. Longer initial squeezes require drastically shortened breather periods if a high specific gravity is desired. Generally speaking, the longer initial squeeze is economically desirable because it shortens the pressing cycle.

Although the magnitude of the initial squeeze pressure is the principal factor in determination of the final specific gravity, a variation up to 6% in specific gravity may occur through changes in the interrelationships between initial squeeze time and breather time. These specific gravity variations in turn result in a variation of about 10 to 12% in the modulus of rupture. Thus it becomes evident that care must be taken to follow the chosen pressing cycle exactly.

An additional increase of up to 15% in the modulus of rupture can be obtained in a hardboard pressed at a temperature between 300 and 400°F. by holding it at platen temperature for a period of an hour at the end of the pressing cycle. However, such a nominal increase in strength is offset by the increased brittleness of

the board and by the uneconomical increase in press-holding time. The most practical possibilities of improving hardboard properties and uniformity lie in the manipulation of the three-stage pressing cycle.

The shape of the temperature-time curves should be of considerable assistance in applying the foregoing principles to a selection of the proper three-stage schedule. The height of the initial temperature rise is an index of the danger of impending blowout. The smoothness of the final temperature rise is an index of the amount of moisture remaining in the mat after the breathing period. Too much moisture is indicated by great irregularities in the curve and results in water-marking of the surface of the board. However, the presence of a small amount of moisture is necessary to obtain maximum specific gravity in a board, and an inflection point in the last temperature rise usually indicates a board of higher specific gravity than is obtained from a smooth temperature-rise curve.

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The Determination of Phenyl Mercuric Salts in the Paper Mill System

ARTHUR SCHWERDLE

A practical method for determination of phenyl mercury salts in the paper mill water system is described. Diphenyl dithizone is used to determine phenyl mercury without intermediated degradation to mercury. The test method is a simple visual color change. Used in four mills, it was found possible to find phenyl mercury ions in the system as well as note duration and concentration. The method has been found of diagnostic value in slime control.

An apparently practical method for determining the presence of phenyl mercury salts in minute quantities in paper mill systems has been evolved. Based on a simple color change, the course and concentration of this bactericide may be followed in the mill water. The test has been utilized in several mills with, in some instances, a noteworthy corrective influence. In all cases phenyl mercury was detected at a bacteriostatic level. The method is useful in determining phenyl mercury ions in dilutions up to one in 100,000,000 with a degree of quantitative accuracy.

It has been known for some time that diphenyl dithiocarbazone (abbr. dithizone and DTZ) (*1*) will undergo color change when in an organic solvent contacted by aqueous solutions of heavy metals (*2*). The mercuric ion has been described as detectable at a concentration limit of 0.25 gamma (*3*). The possibilities of the reaction as a phenyl mercury ion indicator through the intermediate destruction of the organic bond by halogen was considered. This well-defined reaction is frequently useful in organic synthesis and degradation (*4*).

Fortunately, however, it was discovered that the phenyl mercury ion would react to DTZ in the same manner as to the mercuric ion except, as would be expected, and was verified by reference to a mercuric ion standard, it reacted as a monovalent ion. This observation obviated the intermediate degradation step and attendant difficulties. It was further noted that the limits of concentration imposed on the mercuric ion by earlier literature could easily be exceeded one hundredfold by the phenyl mercuric ion and made quantitative to a plus or minus 15% accuracy at high dilutions.

At about the same time or earlier than the herein described work, Gran (*5*), in connection with studies on fungus metabolism, also found that phenyl mercury could be determined directly by use of DTZ without intermediate degradation. The work of Gran apparently was limited to laboratory investigations but was carried out with greater accuracy by use of a photometer. For purposes of simplicity in paper mill determinations visual inspection is quite adequate. It is significant that Gran used the test method in the same dilution range—a range falling within the paper mill microbiological control concentrations.

The practical macrochemical phenyl mercury ion indentification limit proved to be the same as noted by previous investigators (*3*) for the mercuric ion. Indeed, the extension to higher dilutions depended simply upon the observation that by agitating a small amount of DTZ in benzene with a large volume of the unknown, the phenyl mercury could be quantitatively extracted by the DTZ into a yellow-orange chelate complex. As is often characteristic of a strong chelation, the chelated chemical is so tightly bound that dissociation of the complex is practically nonexistent. Such chelation would account for phenyl mercury extraction at an observed concentration level of one to one hundred million.

For convenience of procedure, the arbitrary range of concentration was selected as being the range encompassed by the concentration 1:100,000 to 1:10,000,000. Although the limits could be extended higher and lower, there seemed little or no justification for this since such concentrations appear neither necessary nor practical in slime control. Mill concentrations fell within these levels during the exercise of slime control. The

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thod has been tested in mill systems manufacturing erse paper products. The phenyl mercury ion was nd in solution with substantially equivalent results.

Some slimeacide manufacturers prefer to use a mixe of toxicants, often comprising phenols or chlorind phenols with phenyl mercury. The use of this ixture does not preclude the test; such a composiion will also show phenyl mercuric ion in the paper ill system. No solid phenyl mercury salts as are ded to the beater in envelopes have been tested as et, but the test might be helpful in determining the idity and quantitative extent of solubilization of h products. Studies could likewise be extended to yl mercury and pyridyl mercury ions.

The prime intent of the test development was of rse to determine the concentration and duration of nyl mercury in the paper mill system and correlatg it with microbiological control. Knowing the minin effective level would do much to clarify the issues olved in the slug versus continuous feed discussions well as manner and point of addition generally.

Simply knowing by test whether or not the toxicant reaching a particular zone of slime formation is of siderable prognostic value. As example, in a spefic instance, a mill with only a very moderate bacteria unt was experiencing excessive slime deposits despite avy doses of phenyl mercury salts, mixtures of henyl mercury and chlorphenols, and slime dispersts. Tests showed no phenyl mercury ion to be resent in the system despite massive additions. The ill personnel (*6*) discovered that the toxicant would ot dissolve in the mill water but would dissolve in stilled or tap water. This mill drew water from a ver which at high tide contained decided quantities salt which precipitated the phenyl mercury as the latively insoluble chloride. They found that by aking a dilute stock solution of toxicant with city ater, the toxicant could be added to the system at a lution such as to prevent precipitation of the toxint. A positive test was thereupon shown by the stem and the toxicant requirement substantially duced.

The method has potential usefulness in determining e phenyl mercury content in paper. It also may be ed to determine possible phenyl mercury content in e confluence of mill effluent and natural waters. is water many miles further on may be used by a y. The test seems delicate enough to decide whether e water is safe since the test is indicative at an inscuous level.

ETERMINATIONS IN PAPER MILL WATER SYSTEMS

raft Mill

Phenyl mercuric acetate was added as a 33$^1/_3$% lution once a day over a $^1/_2$-hr. period at a rate of 1 oz. toxicant per ton of paper produced per day at the achine chest. The phenyl mercuric ion could be nd in the system at a concentration of more than 1 10,000,000 for 2 hr., then fell below this level after hr. After 4 hr. no trace was present. This mill d an open water system.

rrugated Paper Mill

A phenyl mercuric acetate solution was added to the ock chest over a $^1/_2$-hr. period. A total of 15 lb. of the toxicant was added. The system tested negative to the phenyl mercuric ion for $^1/_2$ hr. after the addition of the toxicant. Samples were taken from the headbox. After $^1/_2$ hr. the concentration of phenyl mercury rose to 1 part to 4 million, 1 to 2 million, and then, after 1 hr. diminished to a concentration of 1 part to 8 or 9 million. System of mill 60% was closed producing 150 tons per day.

Semichemical Pulp and Rag Stock Roofing Mill

One ounce of toxicant per ton of paper was added as a 33$^1/_3$% solution over a $^1/_2$-hr. period three times a day. In this mill system the white water was returned to a common reservoir from a number of machines and then co-mingled with new stock. The level of phenyl mercury ion was maintained at close to 1 to 5 million during and between the additions due to the capacitance of the system. Thus, whether phenyl mercury circulates in the entire system or only in part as in the next description considerably determines, as would be expected, the concentration and duration in a given system. As a matter of record, the incoming water at this mill was found to have a negative phenyl mercury reading. This was of course checked because of the persistence of the toxicant.

Boxboard Mill

One cylinder of one machine (liner vat) was chosen for addition of the usual dose of $^1/_5$ lb. of phenyl mercury in solution to the localized system of cylinder vat, mixing box, headbox, and screen system containing about a 2400 gal. capacity and therefore attaining a theoretical phenyl mercury concentration of 1 in 1,000,000. This was in the median range of the DTZ test method. The stock was recycled at the rate of 800 to 1000 g.p.m. and had a 100 g.p.m. overflow. The system was phenyl mercury negative at the start of the test. When tested at the cylinder white water effluent the system showed a phenyl mercury concentration of 1 part to 400,000 parts 5 min. after addition and 1:600,000 parts 10 min. after. Ninety minutes after addition the phenyl mercuric ion concentration was below 1 part in 10,000,000.

All these mills were effecting slime control over several years duration with the phenyl mercury toxicant added at the indicated level. Without toxicant, slime interfered with production.

ANALYTIC METHOD

Dithizone has a molecular weight of 256 as compared to 336.6 for phenyl mercuric acetate. Therefore on a molecular equivalence basis, 1 weight unit of PMA would require 256/336 or 0.7619 unit of DTZ.

The limiting color visibility of DTZ is at about 1 mg. per liter of solvent when seen through a volume of 2 ml. Therefore, a concentration of 7.65 mg. per liter of test solution, 1 ml. of which would theoretically be equivalent to 1 ml. of 1:100,000 PMA was chosen as a standard. Thiophene-free benzene is chosen as organic solvent rather than carbon tetrachloride or chloroform in order to avoid possible complications due to traces of chlorides or phosgene. Further, being lighter than water, it floated on the surface in the narrow neck of the test vessel thus making readings convenient.

A stock solution of reagent consisting of 76.19 mg. DTZ per liter is prepared and stored in a ground glass, stoppered pyrex bottle. It appears to be stable indefinitely. When needed, this stock solution is diluted 10 to 1 with benzene and is ready to use.

Dithizone as dissolved in benzene is a beautiful dark green. When shaken with water this color changes to a murky red-purple. Alkali salts form red water-soluble salts. To avert this complication the solution to be tested is slightly acidified. Under slightly acid conditions the green color is maintained. The acid must be added to the aqueous solution to be tested before the DTZ otherwise the purple color is generated and it is difficult to restore to green. Addition of a few drops of 5% sulphuric acid is sufficient to stabilize the color.

When either the red-purple colored DTZ benzene solution or the green DTZ solution is contacted with sufficient PMA or mercuric ion in aqueous solution to effect a complete change, the color in the benzene changes to orange-yellow. The green indicator color rather than the red-purple is prefered because with it incomplete neutralization is characterized by an olive-green color.

After the stock reagent is prepared, it is necessary to check it against a PMA solution of known high dilution. 1:100,000 is selected as an easy reference standard. The volumetric equivalence is then determined. A duplicate blank test must be run employing the same water, vessels and reagents in order to assure the absence of interfering substances or traces of the substance to be tested.

Procedure

A 100 or 1000-ml. glass stoppered volumetric flask (depending on range of investigation) is used as test vessel.

In order to standardize the equivalence of the reagent solution against PMA, the reagent is shaken with varying proportions of a 1:100,000 solution of phenyl mercury acetate. In order to prepare the phenyl mercury standard reference solution, the method of Pesci (*7*) may be used wherein 5 grams of pure phenyl mercuric acetate may be suspended in a 10% aqueous ammonium acetate solution and dissolved by cautious gradual addition of ammonium hydroxide to cause solubilization. Do not exceed pH 8, let stand 24 hr. and filter. This solution may be diluted about 4 to 1 and then titrated against 0.05 *N* KCNS using ferric nitrate indicator and excess nitric to prevent precipitation of ferric hydroxide. The method (*8*) is entirely analogous to the Volhard silver titration. The solution may now be adjusted to exact strength by diluting to 1:1000 and by progressive dilution to 1 to 100,000 and used as a standard.

The DTZ method is not quantitative in the sense of the discontinuity of one ion and generation of another as an excess which causes color change as in the Volhard titration nor yet the abrupt change as in pH indicators but the indicating chelate or reactant does show color at such high dilution as to be its own indicator as in the instance of a permanganate titration.

In order to standardize the DTZ solution by titer, 10 ml. of the reagent is shaken with 1 to 10 ml. of 1:100,000 PMA noting at which point clear amber (yellow-orange) ceases to be generated and, instead, an olive-green or yellow-green persists.

Thus, for example, the standardization may be typified as follows:

Reagent, ml.	*PMA, ml. 1:100,000*	*Color*
10	10	Yellow
10	8	Yellow
10	6	Yellow
10	4	Olive green
10	2	Green
10	5	Yellow

In this manner it is established that 1 ml. of 1:100,000 PMA will neutralize 2 ml. of the prepared DTZ solution.

The test reaction is best accomplished by shaking 2 ml. of the DTZ test solution (as above standard) with a measured volume of unknown selecting progressively greater volumes until a positive (amber) test is achieved. A slightly lesser and greater portion should be used in order to verify the end point.

Thus for instance, using a 100-ml. ground glass, stoppered volumetric flask, the procedure is to shake 1, 10, and 100 ml. of the unknown with 2 ml. DTZ and then water dilute to bring the benzene into the narrow neck portion of the flask where a comparative reading can be taken. After finding these positive or negative, suitable interpolation as in the standardization will yield the end point. Two milliliters of DTZ solution as herein described will identify 10 gamma of phenyl mercury whether it be contained in 1, 10, 100, or (1000-*X*) ml. of solution—thus covering the range of 1 part in 100,000,000 to 1 part in 100,000. In order to identify the phenyl mercury at high dilution it is necessary to shake the benzene with the solution vigorously for 5 or 10 min. The concentration limit is not critical—it just takes longer to extract the phenyl mercury out of more dilute solutions. The identification of 10 gamma is forty times the ultimate obtainable (0.25 gamma) as mercuric ion according to the literature (*3*).

When testing semichemical pulp white water it is necessary to acidify to the point of precipitation of the solid matter and then filtering prior to testing. In any event, filtering off suspended matter prior to testing promotes a clean extraction by the elimination of benzene-water interface emulsion interference and does not affect the test.

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Received June 9, 1952. Presented at the 37th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 18–21, 1952.

ASSOCIATION NEWS AND EVENTS

Fourth Coating Conference

The Fourth TAPPI Coating Conference will be held at the Netherland Plaza Hotel, Cincinnati, Ohio, on May 25–27, 1953.

The program of Monday, May 25, will be devoted to "Coated Paper for offset Printing." A. C. Zettlemoyer of the National Printing Ink Research Institute, Lehigh University, Bethlehem, Pa., is Program Chairman. The following papers will be presented:

1. "Coated Papers for Offset Printing," by A. T. Reynolds, S. D. Warren Co., Cumberland Mills, Me.
2. "Offset Inks for Coated Paper," by F. J. Dankert, Sun Chemical Corp., New York, N. Y.
3. "Offset Printing of Coated Papers," by Charles F. King, U. S. Printing & Lithograph Co., Cincinnati, Ohio.
4. Paper by David W. S. Riddell, Montreal Lithograph Co., Montreal, P. Q.

The program of Tuesday, May 26, will be devoted to "The Coating of Board," J. T. Loomer, Robert Gair Co., Uncasville, Conn., is Program Chairman. Papers will be presented by representatives of the following companies:

1. Gardner Board and Carton Co., Lockland, Ohio.
2. National Folding Box Co., New Haven, Conn.
3. Container Corp. of America, Chicago, Ill.
4. Lord Baltimore Press, Baltimore, Md.
5. Panel Discussion on Offset Printing.

On Wednesday, May 27, any general papers available will be presented. Arrangements are being made for inspection tours to the plants of the Gardner Board and Carton Co., Lockland, Ohio, U. S. Printing & Lithographing Co., Cincinnati, Ohio, and The Mead Corp., Chillicothe, Ohio. John Davis of The Mead Corp. is Transportation Chairman.

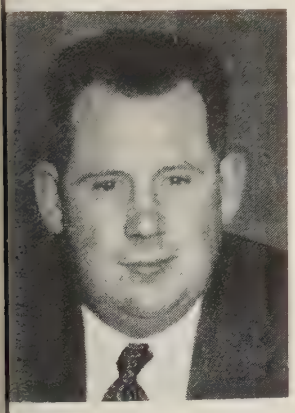
Room reservations at the Netherland Plaza Hotel should be made direct with the hotel. Since it may be difficult to make reservations at a later date early reservations are advisable.

Eighth Engineering Conference

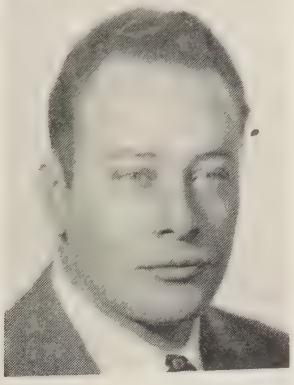
The Eighth TAPPI Engineering Conference will be held at the Sheraton-Mount Royal Hotel, Montreal, P. Q., on Oct. 27–29, 1953.

Seventh Alkaline Pulping Conference

The Seventh TAPPI Alkaline Pulping Conference will be held at the Rice Hotel, Houston, Tex. A feature of this meeting will be an inspection tour of the mills of the Champion Paper & Fibre Co. at Pasadena, Tex., on Nov. 18–20, 1953.



H. Heuer, Great Northern Paper Co.; Chairman, Coating Committee



Burt Mendlin, Cornell Paperboard Products Co.; Chairman, Corrugated Containers Committee

Corrugated Containers Committee

Burt Mendlin of The Cornell Paperboard Products Co., Milwaukee, Wis., has succeeded F. D. Long of The Container Corp. of America, Chicago, Ill, as Chairman of the Corrugated Containers Committee. W. W. Marteny of the National Container Corp. of Wisconsin, Tomahawk, Wis., has succeeded Mr. Mendlin as secretary of the committee.

Local Section Meetings

Pacific: March 13, 1953, Monticello Hotel, Longview, Wash.: Annual Shibley Award Competition. May 22–23, 1953, Joint Meeting with the Pacific Division, Superintendents' Association, Gearhart Hotel, Gearhart, Ore.

Lake States: March 10, 1953, Northland Hotel, Green Bay, Wis., "Savealls." April 15, 1953, Elks Club, Wisconsin Rapids, Wis., "Fourdrinier Operation and Defects Attributable to Such Operation." Visit to Nekoosa-Edwards Paper Co. mill at Port Edwards, Wis.

Delaware Valley: March 26, 1953, Engineers Club, Philadelphia, Pa., "Increased Production from Existing Machines," by John R. Curtis, Scott Paper Co., Chester, Pa. April 23, 1953, "Paper Defects," Panel Discussion led by L. P. Thompson, Personal Products Corp., Milltown, N. J.

Kalamazoo Valley: March 19, 1953, Harris Hotel, Kalamazoo, Mich., "Graphic Arts." April 2, 1953, "Sizing-Rosin, Starch and Synthetic Chemicals."

New England: March 20, 1953, Hotel Roger Smith, Holyoke, Mass., "Routine Control Methods." June 19–20, Poland Spring House, Poland Spring, Me. Joint Meeting with Maine-New Hampshire Section.

Ohio: March 10, 1953, Manchester Hotel, Middletown, Ohio, "Selection of Technical Personnel," by J. Edward Todd, Institute of Paper Chemistry, Appleton, Wis. April 9, 1953, Springfield, Ohio, Visit to Bauer Bros. Co. and Crowell Collin Publishing Co.

Empire State (Northern District): March 12, 1953, Woodruff Hotel, Watertown, N. Y., "Sell for America," W. F. Luckenbach, Jr., Virginia Smelting Co., West Norfolk, Va. April 9, 1953 "Recent Developments in Paper Machine Drives," by S. E. Franklin, Westinghouse Electric Corp., East Pittsburgh, Pa.

Empire State (Central District): March 6, 1953, University Club, Syracuse, N. Y.

Empire State (Eastern District): March 19, 1953, Milfrank's Restaurant, Glens Falls, N. Y. Annual Paper Presentation Competition. April 16, 1953, Inspection Tour of United Paper & Board Co. mill at Schuylerville, N. Y., and the Stevens & Thompson Co. mill at Greenwich, N. Y.

Lake Erie: March 20, 1953, Carter Hotel, Cleveland Ohio, "Surface Characteristics for Printing." April 17, 1953, "General Maintenance for the Converter."

Southeastern: March 20, 1953, Hotel Dempsey, Macon, Ga. May 8, 1953, DeSoto Hotel, Savannah, Ga.

Maine-New Hampshire: June 19–20, 1953, Poland Spring House, Poland Spring, Me. Joint meeting with a New England Section.

Empire State (all Districts): June 8–10, 1953, Whiteface Inn, Lake Placid, N. Y.

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Warren A. Abbott, Technician, University of Maine, Dept. of Chemical Engineering, Orono, Me.

Ralph W. Allen, Technical Director, Cochran Foil Co., Louisville, Ky., a 1941 graduate of the University of Richmond.

Clifford R. Anderson, Assistant Chief Engineer, Freight Loading and Container Bureau, Association of American Railroads, Chicago, Ill., a 1926 graduate of Rensselaer Polytechnic Institute.

Kenneth H. Anderson, Resident Engineer, Marathon Paper Mill Ltd., Marathon, Ont., Canada, a 1934 graduate of the University of Saskatchewan.

George G. Arthur, Coordinator of Training, The Champion Paper & Fibre Co., Hamilton, Ohio.

Andre Asselin, Plant Engineer, Rolland Paper Co. Ltd., St. Jerome, P. Q., Canada, a 1943 graduate of Ecole Polytechnique, Montreal.

Elias Baltin, Assistant Plant Manager, Peter J. Schweitzer, Inc., Elizabeth, N. J., a 1939 graduate of the College of the City of New York.

Sidney J. Baum, General Manager, American Polymer Corp., Peabody, Mass., a 1941 graduate of Columbia University with a Ph.D. degree.

Daniel E. Bivins, Jr., Electrical Engineer, Brown Paper Mill Co., Monroe, La., a 1921 graduate of Alabama Polytechnic Institute.

John D. Boadway, Research Engineer, Consolidated Paper Corp. Ltd., Three Rivers, P. Q., Canada, a 1945 graduate of the University of Toronto.

William H. Chandler, Production Manager, Converting Dept., S. D. Warren Co., Cumberland Mills, Me., a 1940 graduate of the University of Maine.

Oliver C. Christiansen, Paper Mill Superintendent, Escanaba Paper Co., Escanaba, Mich., a 1947 graduate of the University of Minnesota.

William M. E. Clarkson, Production Manager, Technical Charts, Inc., Buffalo, N. Y., a 1947 graduate of the University of Toronto.

Harold H. Coffman, Research Chemist, Bareco Oil Co., Barnsdall, Okla., a 1940 graduate of Kansas State College.

Earl D. Cornwell, Technical Director, Adhesive Div., Armour & Co., Chicago, Ill., a 1927 graduate of the University of Illinois.

Joseph R. Coursault, Chemical Engineer, W. H. & L. D. Betz, Philadelphia, Pa., a 1943 graduate of Villanova College.

Enrico Dell'Oca, Technical Assistant, Paper Mill Beniamino Donzelli, Milano, Italy, a 1949 graduate of Industrial Technical Institute.

George H. Dickson, Technical Supervisor, Albemarle Paper Mfg. Co., Richmond, Va., a 1933 graduate of Roanoke College.

Arnold W. J. Dyck, Editorial Director, *The Paper Industry,* Fritz Publications, Inc., Chicago Ill., a 1932 graduate of McGill University with a Ph.D. degree.

Henry J. Essman, Vice-President and Plant Manager, The Weston Paper & Mfg. Co., St. Marys, Ohio.

John F. Gorham, Development Div., American Cyanamid Co., Stamford, Conn., a 1952 graduate of the University of Maine.

Nathan R. Gotthoffer, Consulting Chemist, Cincinnati, Ohio, a 1922 graduate of Cornell University.

Charles G. Griffin, Jr., Control Chemist, Kimberly Clark Corp., Neenah, Wis., a 1949 graduate of the University of Tennessee.

Victor E. Hall, Owner, Victor E. Hall, Consulting Engineers, Syracuse, N. Y. Attended Syracuse University.

Kenneth B. Hill, Sales and Production Manager, St. Joe Paper Co., South Hackensack, N. J. Attended Cornell University.

Carl R. Hoffman, Dept. Supervisor, Western Electric Co., Inc., Chicago, Ill., a 1923 grauate of Montana State College.

Jack F. Johnston, Research Chemist, Union Starch & Refining Co., Granite City, Ill., a 1951 graduate of Kansas State College.

Leif Jorgensen, Assistant Research Director, Billerud A/B, Saffle, Sweden, a 1941 graduate of the Norwegian Institute of Technology with a Doctor of Technology degree.

Joseph W. Judge, Jr., Chemist, Riegel Paper Corp, Milford, N. J., a 1952 graduate of the New York State College of Forestry.

Louis Kahn, Director of Research, Aerovox Corp., New Bedford, Mass., a 1929 graduate of Rutgers University.

James A. Karabedian, Chemist, Lily-Tulip Cup Corp., Augusta, Ga., a 1944 graduate of the College of William and Mary.

George A. Koebke, Sales Manager, Manitowoc Shipbuilding, Inc., Manitowoc, Wis. Attended Michigan College of Maine.

Roland E. Kremers, Research Associate, The Institute of Paper Chemistry, Appleton, Wis., a 1921 graduate of the University of Wisconsin with a Ph.D. degree.

Lloyd T. Krum, Jr., Junior Salesman, International Paper Co., New York, N. Y., a 1949 graduate of Dartmouth College.

David C. Lea, Student, The Institute of Paper Chemistry, Appleton, Wis., a 1949 graduate of the University of Montana.

Leonor L. Lewis, Research Supervisor, E. I. du Pont de Nemours & Co., Inc., Buffalo, N. Y., a 1947 graduate of Purdue University with a Ph.D. degree.

Francis J. McCarthy, Superintendent, Finishing Dept., Falulah Paper Co., Fitchburg, Mass.

Jose Ermirio Moraes, General Director, Cellophane and Rayon plants, Companhia Nitro Química Brasileira, São Paulo, Brazil.

Joseph C. Muller, Sales Engineer, John D. Robinson Co., Savannah, Ga., a 1952 graduate of the University of Georgia.

Kunaratnam Nadarajah, Engineer in Training, Dept. of Industries, Government of Ceylon, Valachenai, Ceylon, a 1951 graduate of Ceylon Technical College.

Marcy B. Newell, Technical Assistant for Paper, Ecusta Paper Corp., Pisgah, N. C., a 1928 graduate of the University of Colorado.

Daniel P. Norman, Director of Chemical Research, New England Spectrochemical Laboratories, Ipswich, Mass., a 1939 graduate of Harvard University with a Ph.D. degree.

Jack H. Oliver, Assistant Superintendent, Mill Technical Dept., Union Bag & Paper Corp., Savannah, Ga., a 1938 graduate of Clemson Agricultural and Mechanical College.

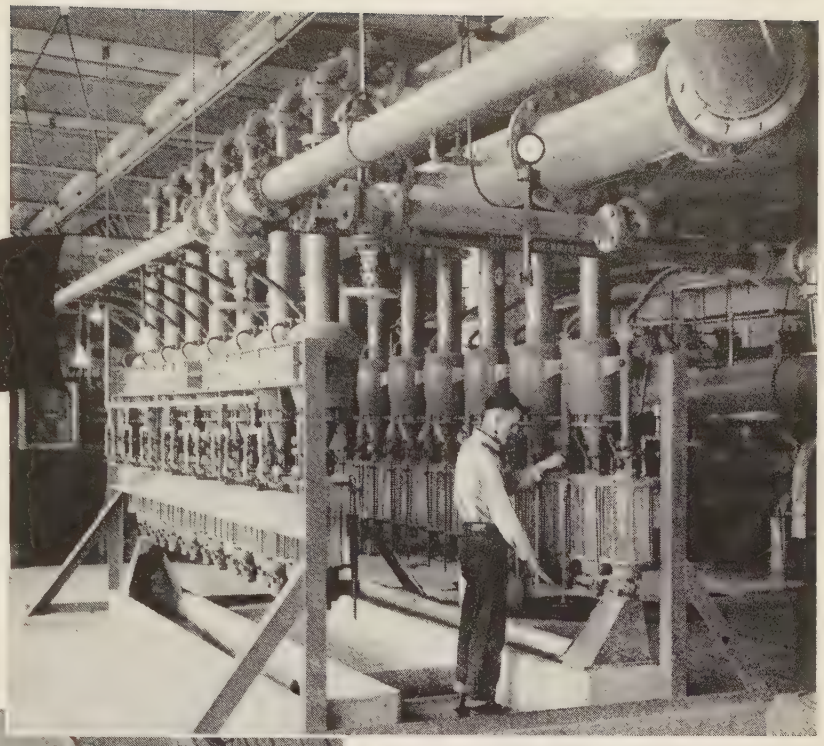
Harry B. Parker, Instructor, Western Michigan College, Kalamazoo, Mich., a 1950 graduate of Western Michigan College.

Donald A. Pearson, Chemical Engineer, Puget Sound Pulp & Timber Co., Bellingham, Wash., a 1948 graduate of the University of Washington.

On Waste Paper Stocks, Too

DIRTECS

Do The Most Effective Dirt Removal Job



Here are two representative Dirtec installations among the dozens that are working on old paper and deinked stocks.

Dirtecs on such stocks, as on all other kinds of stock, produce uniformly clean, bright stock with negligible fibre loss. They take out such tough to handle dirt as asphalt and ink balls.

Dirtecs are easy to install and operate. The dirt collected is out of the stock for good and all — cannot get back into the system.

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John L. Pedrick, Assistant Section Head, Engineering Dept., Scott Paper Co., Chester, Pa.

Justin Popa, General Manager, Combustion Engineering Ltda., São Paulo, Brazil, a 1945 graduate of the U. S. Naval Academy.

Johann G. Reich, Paper Chemist, Badische Anilin & Soda Fabrik, Ludwigshafen a. Rhein, Germany, a 1943 graduate of the University of Marburg, Germany, with a Ph.D. degree.

Christian J. Rettmeyer, Engineer, Ateliers de Construction Allimand, Rives (Isere), France, a 1949 graduate of École Française de Papeterie, Grenoble.

Rene L. Rouvier, Vice-President, Papeteries Riquet, Paris, France. Attended École Française de Papeterie, Grenoble.

Eugene W. Sanders, Supervisor, Wax Section, Cities Service Oil Co., East Chicago, Ind., a 1950 graduate of Valparaiso University.

Henry W. Schmidt, Vice-President, The Upson Co., Lockport, N. Y., a 1928 graduate of the University of Pennsylvania.

Paul A. Spenadel, Field Service Engineer, National Starch Products, Inc., Chicago, Ill., a 1950 graduate of Polytechnic Institute of Brooklyn.

Robert O. Stephenson, Assistant Production Manager, The Champion Paper & Fibre Co., Hamilton, Ohio.

Peter P. Taranoff, Chief Chemist, St. Helens Pulp & Paper Co., St. Helens Ore., a 1941 graduate of Linfield College.

Tatsunosuke Uchida, Mill Manager, Toyo Spinning Co. Ltd., Inuyama-cho Aichi-ken, Japan, a 1932 graduate of Kyoto Imperial University.

Guy E. Uhlig, Shift Chemist, Longview Fibre Co., Longview, Wash., a 1934 graduate of the University of Washington.

Jay G. Weidman, Chemical Engineer, W. H. & L. D. Betz, Philadelphia, Pa., a 1943 graduate of Drexel Institute of Technology.

Felix E. Weisshuhn, Technical Director, Companhia Melhoramentos de São Paulo, São Paulo, Brazil.

Herbert Willoughby, Chief Purchasing Agent, Colgate-Palmolive-Peet, Ltd., Manchester, England.

Peter E. Wrist, Research Physicist, Quebec North Shore Paper Co., Baie Comeau, P. Q., Canada a 1948 graduate of the University of Cambridge, and a 1952 graduate of the University of London.

TAPPI Notes

Henry Akeroyd is now Assistant Production Manager for the Personal Products Co., Milltown, N. J.

Dexter Anderson is now Vice-President of the Plax Corp., Hartford, Conn.

Harold M. Annis is now Technical Director of the Oxford Paper Co., New York, N. Y.

A. N. Ball, formerly Chief Engineer, is now Resident Consultant for the E. B. Eddy Co., Hull, P. Q.

O. A. Battista is now Senior Research Chemist for the American Viscose Co., Marcus Hook, Pa.

John E. Bauman, formerly of the Paper Container Mfg. Co., is now Plant Manager of the Solo Cup Co., Grandview, Mo.

Robert J. Becker, has been released from active service with the U. S. Armed Forces and has returned to the Riegel Paper Corp., Milford, N. J. as a Chemical Engineer.

Luther Beighey, formerly Sulphite Superintendent, is now Consultant for the Hammermill Paper Co., Erie, Pa.

Donald J. Blazer, formerly of the Falls Power & Paper Co., is now Maintenance Engineer for the Marinette Paper Co., Marinette, Wis.

J. Shartle Brookover, formerly of the Gardner Carton Co., is now General Manager of the A. & P. Corrugated Box Co., Lawrence, Mass.

J. Marshall Buehler, formerly student at Marquette University, is now Laboratory Technician for the Nekoosa-Edwards Paper Co., Port Edwards, Wis.

Harry J. Buncke is now Vice-President in Charge of Engineering for the Oxford Paper Co., Rumford, Me.

William H. Caddoo is now Vice-President in Charge of the Folding Carton Div. of the Robert Gair Co., New York N. Y.

Roy L. Davis, formerly Superintendent, is now Vice-President in Charge of Production for the Detroit Sulphite Pulp & Paper Co., Detroit, Mich.

George F. Durand, is now Vice-President in Charge of Engineering for the Port Huron Sulphite & Paper Co., Port Huron, Mich.

John C. W. Evans, formerly of the *Pulp & Paper Magazine of Canada*, is now Editor of the *Paper Trade Journal*, New York, N. Y.

Robert B. Fellows is now General Manager of the South Atlantic Div. of Reichhold Chemicals, Inc., Jacksonville, Fla.

Martin H. Gurley, formerly Consultant, is now Manager of the Technicial Dept. of Duplan Corp., Kingston, Pa.

John T. Hegaman is now Technical Supervisor of the Pulp Div., Brown Co., Berlin, N. H.

Walter F. Holzer, formerly Assistant Director of Research, is now Assistant to the Vice-President in Charge of Manufacture, Crown Zellerbach Corp., Camas, Wash.

Walter W. Holland is now Mill Manager of the Oxford Paper Co., Rumford, Me.

Kenneth H. Hunt is now Technical Director of the West Virginia Pulp & Paper Co., Williamsburg, Pa.

C. James Johnson, Technical Director of the Pollock Paper Co., has transferred from Middletown, Ohio, to Dallas, Tex.

Arthur B. Kaplan, formerly of Milprint, Inc., is now Chemical Engineer for the U. S. Rubber Co., Stoughton, Wis.

William H. Kennedy is now Assistant Superintendent of the Paper Mill of the Hammermill Paper Co., Erie, Pa.

Lawrence Leney, formerly Instructor at the College of Forestry, State University of New York, is now Professor, Dept. of Forestry, University of Missouri, Columbia, Mo.

Earl P. Lovenheim, formerly Paper Mill Manager of the Simplicity Pattern Co., is now Technical Director of the Great Lakes Press Corp., Rochester, N. Y.

Harold G. Maclem is now Assistant Chief Engineer of the St. Regis Paper Co., Pensacola, Fla.

Felix A. Mariani is now Technical Director of the Modena Paper Mills, Modena, Pa.

Thomas F. Martin, Jr., formerly of the Hartford City Paper Co. is now a member of the Supervisory Staff of the Container Corp. of America, Wabash, Ind.

Robert D. McCarron, formerly with Stein, Hall & Co., is now Service and Sales Representative in New England, New York, and Atlantic States for Morningstar, Nicol, Inc., Boston, Mass.

Winslow B. Mills is now General Superintendent of the St. Regis Paper Co., Pensacola, Fla.

Henry W. Mooseker is now General Superintendent of the West Virginia Pulp & Paper Co., Tyrone, Pa.

Bjorn A. Nelson, formerly of Mo och Domsjo A/B, is now Engineer for Pagel, Horton & Co., New York, N. Y.

W. L. Orr is now Pulp Mill Superintendent for the St. Regis Paper Co., Pensacola, Fla.

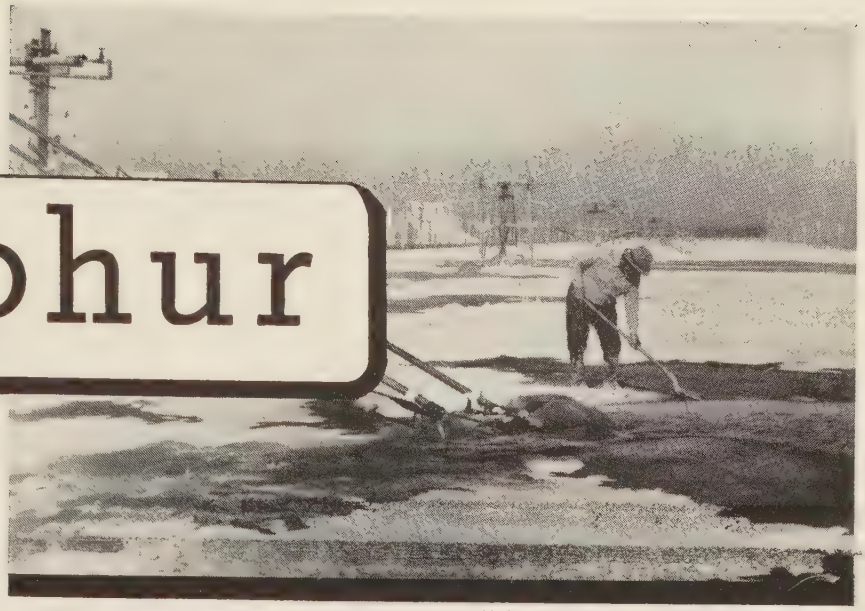
William H. Owens, formerly of Philip Carey Mfg. Co., is now Engineer for the American Rock Wool Co., Wabash, Ind.

Harold L. Peckham, formerly of the Paper Corp. of the U. S., is now Assistant in Product Development for the Oxford Paper Co., New York, N. Y.

Roderick A. Perkins is now Chief Chemist for the Marinette Paper Co., Marinette, Wis.

Vincent Petrucelli, formerly of the Kalamazoo Vegetable Parchment Co., is now Chemical Engineer for the Socony-Vacuum Laboratories, Brooklyn, N. Y.

Sulphur



Molten Sulphur flowing into the storage vat

Thousands of tons mined daily, but where does it all go?

Look around you in any grocery store and what do you see — canned goods of all kinds! Soups, vegetables, fruits, berries! Believe it or not, you're looking at merchandise that consumed a lot of Sulphur in the making.

Tin cans are made of tin plate. Tin plate is made of sheet steel. Sheet steel is made with the help of sulphuric acid—pickling, as they call it, the process that removes scale preparatory to plating. In 1951, the sheet division of our great iron and steel industry is estimated to have consumed 140,000 long tons of Sulphur in the form of sulphuric acid. That in itself makes quite a dent in our supplies of Sulphur. Add to this almost as much more for treating wire rod, plate, strip, bars, etc., and you can see that to make finished steel, regardless of form, the iron and steel industry must use lots of Sulphur in the form of sulphuric acid.

Right here is an excellent example of the interdependence of all of our industries. To produce steel requires a lot of Sulphur. To produce Sulphur and other mined products requires a lot of steel. This interdependence of industries is one of the country's sources of strength.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.

Mines: Newgulf and Moss Bluff, Texas

Henry L. Rammer is now Technical Director for the sixteen plants of Fibreboard Products, Inc., Stockton, Calif.

George H. Rand of the International Paper Co. has transferred from Niagara Falls, N. Y., to Glens Falls, N. Y.

Clifford S. Reppi, is now Manager of the Paper Makers Chemical Dept. of the Hercules Powder Co., Akron, Ohio.

Frank W. Richardson, formerly of the Northwest Filter Co., is now with Hagan Corp. (Canada) Ltd., Vancouver, B. C.

Wilfred W. Scheide, formerly Superintendent of the American Coating Mills Div. is now Assistant to the Vice-President in Charge of the Folding Carton Div., Robert Gair Co., New York, N. Y.

George C. Schmid, formerly of the Starbuck Mfg. Co., is now Laboratory Technician for the Holyoke Card & Paper Co., Springfield, Mass.

Douglas W. Shook, formerly of the Coosa River Newsprint Co., is now Industrial Engineer for the Kimberly-Clark Corp., Neenah, Wis.

Theodore F. Spear is now Vice-President in Charge of Public Relations for the Oxford Paper Co., Rumford, Me.

John J. Steinbinder is now Sales Engineer for Pulp Sales for the Riegel Paper Corp., New York, N. Y.

Walter Stern, formerly of Kraft Foods Co., is now Engineer with Raymond Loewy Associates, New York, N. Y.

John E. Stone, formerly with the National Research Council of Canada, is now a Research Associate at The Institute of Paper Chemistry, Appleton, Wis.

Royal A. Stone, formerly of Rayonier, Inc., is now Engineer in the Chemical Design Div. of Olin Industries, New Haven, Conn.

Roger Strauss is now Assistant Manager of Product Development for the Hammermill Paper Co., Erie, Pa.

John Studeny is now Manager of Product Development for the Hammermill Paper Co., Erie, Pa.

L. T. Summers, is now Secretary and Technical Director of the Port Huron Sulphite & Paper Co., Port Huron, Mich.

R. von Hazmburg is now Supervisor of Fiber Product Research for the U. S. Gypsum Co., Chicago, Ill.

Laurence T. Waterman is now General Superintendent of the Northern Kraft Div. of the St. Regis Paper Co., Watertown, N. Y.

John C. Wilson is now Superintendent of the Wood Room of the Hammermill Paper Co., Erie, Pa.

Virgil O. Wodicka, Assistant to the Scientific Director of the Quartermaster Food & Container Institute, is on leave of absence for eighteen months to take graduate work at Rutgers University, New Brunswick, N. J.

* * *

Walter H. Randall, Director of Engineering and Research, has succeeded *W. E. Parsons*, President, as the official corporate representative in TAPPI of the Keyes Fibre Co., Waterville, Me.

* * *

W. L. Manley has succeeded *R. K. Prince* as the official representative in TAPPI of the Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Arthur L. Landesman, Application Engineer, has succeeded *John O. Larson* as the official representative in TAPPI of Fischer & Porter Co., Hatboro, Pa.

Industry Notes

Production

Present estimates of paper and paperboard production in the United States in 1952 amount to about 24,500,000 tons, about equally divided between the two products.

The national consumption of wastepaper in 1952 was between 7,800,000 and 8,000,000 tons. Paperboard mill consumption probably will run close to 6,000,000 tons, paper mill consumption 1,160,000 tons, and the consumption of wastepaper by roofing building materials mills about 750,000 tons, about as much as they consumed in 1951. Consumption of wastepaper by the building materials mills in October set a new high for those mills, exceeding by almost 2000 tons of this consumption of 74,419 tons in May, 1951.

Wages

Pulp, paper, and paperboard mill workers averaged $1.52 an hour in April, 1952, exclusive of late-shift and overtime premiums, according to a survey made by the U. S. Department of Labor's Bureau of Labor Statistics. The earnings of individual workers ranged from less than 90 cents to more than $2.50 an hour. Approximately a fifth of the workers received less than $1.30 an hour and about the same proportion had earnings of $1.75 or more. Average hourly earnings in five of the seven regions clustered closely around the average for the United States, ranging from $1.46 in the central region to $1.55 in the midwest. Workers in New England averaged $1.39 and in the Pacific region, $1.86 an hour.

About two fifths of the 173,000 production workers were employed in the 46 selected occupations. In pulp production, cooks (digester operators) and recovery operators had the highest average earnings ($1.88) and drum barkers ($1.38) and grinder men ($1.44), the lowest.

In the manufacture of paper and paperboard, paper-machine tenders were the highest paid workers in the occupations surveyed, averaging $1.97 an hour. Among other occupations, back tenders averaged $1.72; third hands, $1.57; and fourth hands, $1.45.

The maintenance jobs studied included electricians ($1.87), pipe fitters ($1.86), machinists ($1.83), and millwrights ($1.80). Janitors averaged $1.35 an hour and were the lowest paid of the men's occupations studied.

A work schedule of 40 hours a week for first-shift workers was reported by mills employing approximately three fourths of the workers. Nearly half of the production workers were employed on late shifts. The most common shift differentials were 4 or 5 cents an hour on the second shift and 6 or 10 cents for third-shift work.

Paid vacations of 1 week were usually provided after 1 year's service, 2 weeks after 5 years, and 3 weeks after 15 years. Almost half the workers were employed in mills granting six paid holidays and a fourth in plants providing four paid holidays annually. Some type of insurance or pension plan was financed, at least partially, by nearly all employers. Health insurance, hospitalization, life insurance, and retirement pensions were provided by establishments with a majority of the workers.

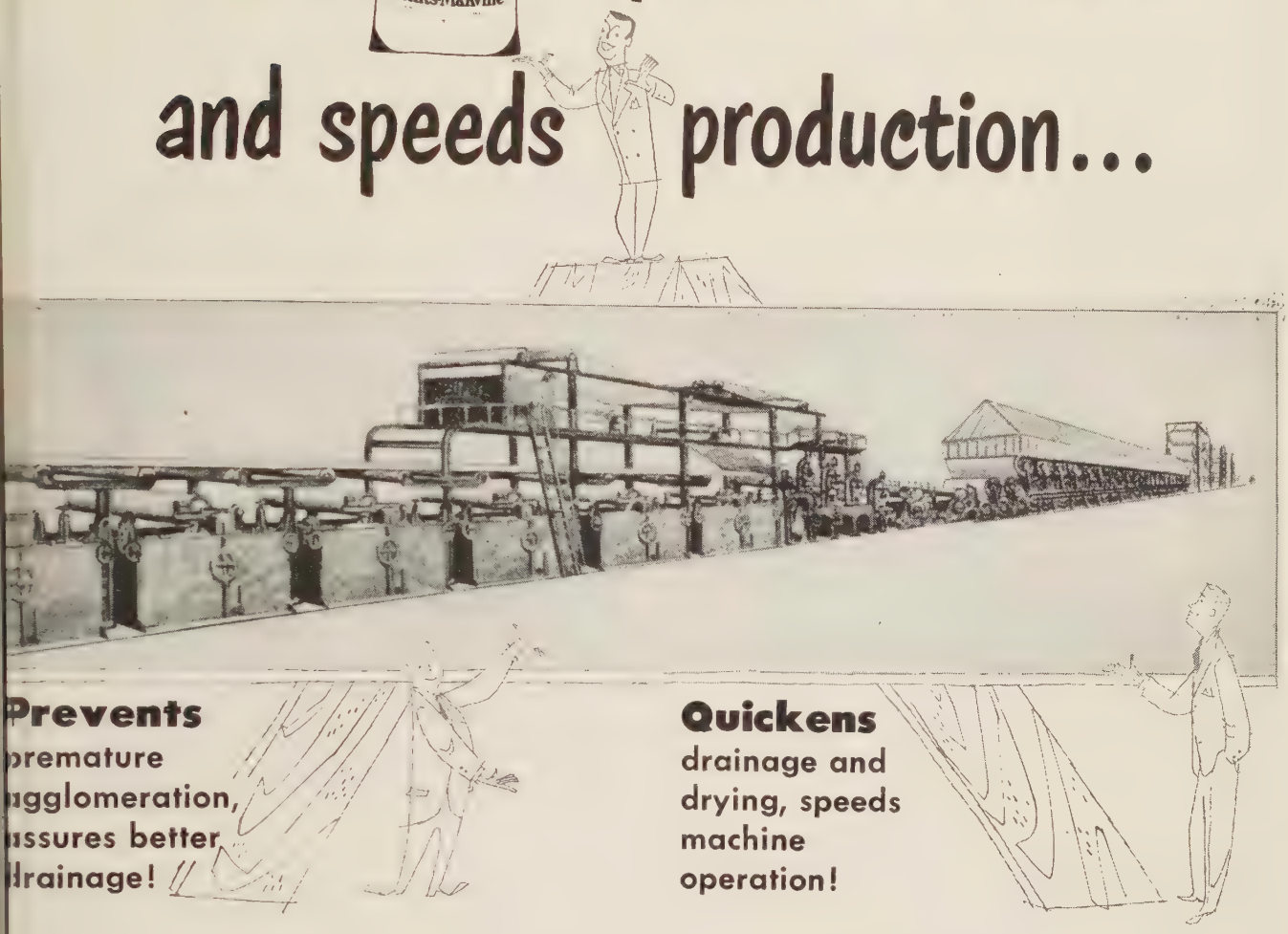
Canada

In *The Gazette*, Montreal, P. Q., on Jan. 9, 1943, R. M. Fowler, President of the Canadian Pulp and Paper Association, outlined conditions in the Canadian industry as follows:

In the past year, the pulp and paper industry of Canada maintained a high level of production. It also finally gained an objective for which it has long striven, namely, to bring supply into balance with the ever-increasing demand of the seven postwar years. But the relationship between the overall supply of pulp and paper and the demand remains extremely narrow, so narrow indeed that a minor upturn in consumption would temporarily strain the productive capacities of the mills.

The total output of the mills during the year was 2% lower than in 1951 and some 6% higher than in 1950. Such a minor fluctuation in output reveals that there has been no fundamental change in the situation surrounding the industry, or in its long-term prospects which are based on the fact that there exists a real and growing need for wood fiber and its products throughout the western world.

How JM CELITE Johns-Manville improves formation and speeds production...



Prevents premature agglomeration, assures better drainage!

Quickens drainage and drying, speeds machine operation!

Just add a small amount of Celite* to the furnish of your board machines, and you'll find that formation troubles disappear . . . and production is stepped up.

Here's how Celite works: During formation, Celite's porous, irregularly shaped particles help keep the fibres more uniformly dispersed—thus preventing premature agglomeration. This provides better channels for the flow of water . . . gives the initial mat uniform drainage. The result is faster drainage and drying which permits as much as a 10% increase in machine speeds.

Why not ask a Celite field engineer to call and discuss the use of Celite in your mill? In addition to solving your formation problems . . . there are other ways in which Celite can help you produce better paper at lower cost. Just write to Johns-Manville, Box 60, New York 16, N. Y. In Canada write 199 Bay Street, Toronto 1, Ontario.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CELITE PRODUCTS

FOR THE PAPER INDUSTRY

During the past year, the industry maintained its leading position in the expanding economy of the nation. It remains the largest breadwinner in the land and once again last year created far more than $1 billion in national wealth.

In 1952 Canada produced some 8.7 million tons of wood pulp as compared with 8.9 million tons in 1951. The output was substantially greater than the 8.2 million tons produced in 1950. Some 78% of the pulp output was converted in Canada into paper and paperboard of which the total was maintained at approximately the level of the preceding year. The slight decline in the over-all production in the industry stemmed chiefly from a decline in the pulp which moves abroad.

Final figures covering pulp exports in 1952 will run to some 1.9 million tons, a figure equaling exports in 1950 but below the all-time record of 2.2 million tons last year. The decline in exports is chiefly accounted for by inventory corrections among consumers in the United States which takes some 80% of all Canadian pulp exports. It may take time for the pulp demand abroad to reach the level attained in 1951, but meantime some inventory adjustments appear to have run their course. For example, during the past autumn, the operating ratio of the U. S. paperboard mills was substantially higher than in the closing months of 1951. Although exports of bleached sulphite pulp declined by almost

Growth of Pulp and Paper Industry

	Pulp & paper mills	*Total employees*	*Total production*
1952[a]	130	57,000	$1,200,000,000
1951	130	52,600	1,200,000,000
1941	106	37,154	334,726,175
1931	103	26,669	174,733,954
1921	100	24,619	151,003,165
1911	72	9,766	23,226,479
1901	53	6,236	8,627,557
1891	58	2,917	3,633,257
1881	41	1,588	2,509,993
1871	21	760	1,071,651

[a] Estimated

9%, the downturn in the demand abroad affected to an even greater degree the exports of the unbleached chemical and groundwood grades. Exports of bleached sulphate pulp, though, remained at the 1951 level.

With newsprint, at long last some leveling off in the demand occurred in North America where consumption increased by something less than 1% during the year. Shipments overseas, though, jumped by 45%. As only some 9% of newsprint exports move overseas, the output of the mills increased by 3½%, or from 5.5 million tons in 1951 to close to 5.7 million tons in 1952.

The maintenance of the demand for newsprint on this continent during a period of smaller demand for other papers, for paperboard, and for pulp, emphasizes two fundamental characteristics of this commodity, the raw material of the newspaper. The first is its stability as compared with most commodities for which the ups and downs in the demand are apt to be more volatile and exaggerated. Even in the great recession of 1929–32, world demand for newsprint declined by only 13%. And second, the consistent growth of this sector of the industry has been in step with the potentialities of its long-term trend.

While the past year witnessed no apparent shortage of newsprint paper, nevertheless it is not without significance that, to meet the demand, Canadian mills continued to increase their capacities and had to operate at a level 3% higher than the accurately rated capacities of the mills at the beginning of the year.

Part of the 1952 increase in capacity occurred when a new mill on the Pacific coast came into operation in midyear adding 75,000 tons, or less than 1½% to the total annual capacity of the industry. Until this summer, only one new newsprint mill had been completed in Canada since 1932; the postwar increase in capacity of roughly one million tons was accomplished by expanding the capacity of existing mills.

Paperboard production in 1952 ran to some 684,000 tons as compared with 757,000 tons and 712,000 tons in two respective preceding years. The drop in output was occasioned in part by inventory readjustments on the part of consumers. Output of container boards declined by 8% and boxboards by almost 11% as compared with 1951. Ten per cent of the paperboard production was exported in 1952 as compared with 11% in the preceding year. Production of fine paper in Canada during the year ran to 180,000 tons in 1952, a slight increase over 1950 but somewhat below the record production of 203,000 tons in 1951. In 1952, fine paper exports amounted to 7% of the output as compared with 5% in 1951. Similarly, the output of wrapping paper in 1952 of 222,000 tons was somewhat higher than in 1950 but below the 253,000 tons produced in 1951.

A problem facing the industry a year ago was the sulphur shortage. Meantime domestic sources of supply have been developed with the result that in 1953 about one third of Canada's sulphur needs will be met domestically. This with other steps to increase the supply has eased the situation. Both the U. S. and Canada have lifted the restrictions on sulphur of which the pulp and paper mills account for about 80% of the total Canadian consumption.

Perhaps the most significant aspect of the development of the industry in the past 12 mo. has been increasing emphasis which the mills have placed on research, both fundamental and applied, in its forests and in the mills. Such effort, of course, is the very foundation of its future particularly in a world where the frontiers of science are widening day by day.

To develop further fundamental knowledge, the Technical Section of the Canadian Pulp and Paper Association sponsored in 1952 a World Pulping Conference, in which the leading scientists in this field throughout the world participated.

The scale of activities at the Pulp and Paper Research Institute of Canada are now about four times as great as they were three years ago. Substantial progress is being made both in fundamental and applied research because it is now possible to throw complete research teams into individual industry problems and projects.

The objective is to make the Institute the leading world center of knowledge of wood, wood cellulose, and paper products. It is already far along that road. As a result, pulp and paper producers abroad are following and taking an intense interest in developments originating in the Institute, a leading Canadian research organization.

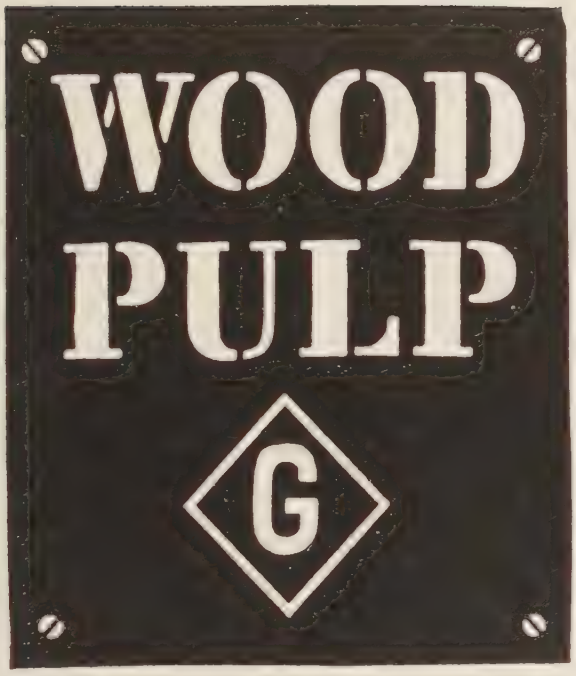
Many individual mills have made substantial contributions to the development and application of scientific knowledge to pulp and paper operations. In 1952 one company brought into production a large subsidiary producing an array of chemical products made from lignin, the residue of the chemical pulping process.

In New Brunswick, one mill in conjunction with the federal and provincial authorities, made an aeroplane assault on the budworm plague by spraying 300 square miles of infested woodlands. A measure of the success attained in this attack on a fundamental forest problem is gained from the fact that next year the four large companies in the province will also take part in an expanded operation in which it is planned to spray several thousand square miles of forests of which 1500 miles will be sprayed in 1953.

The participation of the federal government, with the province and the mills, in measures such as this has heartened all those who realize that the future of Canada largely depends on the maintenance of her forest wealth.

Throughout the industry progress has been made in devel-

Established 1886



"to strive, to seek, to find."
ALFRED LORD TENNYSON

The Pulp and Paper Industry typifies the spirit of endeavor, research and discovery. Behind the stronger wrapper, the whiter paper, the newer package, is the tireless search of the scientist and the laboratory technician. They know each improvement leads to another path to be explored in the never-ending effort to achieve something better.

★

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— INCORPORATED —

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oping a more efficient and complete use of wood. Decided economics have been made in chemical pulping. More tree species are employed. And logs are being put to the use for which they are best suited. In Ontario a company has been formed by forest operators solely for this purpose. Again, pulp mills are making a more complete use of sawmill waste and indeed are being operated on waste and small logs harvested by timber producers. Indeed in British Columbia more than one mill is operating on small wood, cull logs, sawmill waste and other materials which hitherto were wasted.

Today, the pulp and paper industry in Canada is in a period of transition, not only in the mills, but in the woods. The industry has thousands of test plots throughout its forests from which it is constantly gaining new knowledge of how to grow more wood and how to cut the forests more economically and more fruitfully. The mills have made no small contribution to progress by an increasing utilization of hardwoods in the pulping process. Some companies are setting up their own experimental forest areas in which cutting methods best suited to maximum yield are being developed. Others are conducting pathological and entomological studies. Still others are active in forest extension work spreading the knowledge of proper forestry methods among the private woodlot owners. One company operating in suitable territory has set up permanent communities each harvesting, and each looking after an individual sector of the woodlands. Here all the workers have a direct interest in maintaining the forest; and fire and other hazards occasioned by the seasonal and nomadic worker are avoided.

Even the production of paper in itself tends to conserve the forests. For example, paperboard has largely supplanted wood as a container. If lumber now occupied its former position as a raw material for boxes and crates, we would use many times the number of trees now required to provide paperboard containers.

Again, the industry is making exploded pulp which is converted into materials which supplant lumber. But this exploded pulp is made chiefly from what was formerly useless material: sawdust, slabs, screenings, and sawmill waste. Finally, the plywood industry makes better woods go further and utilizes, also, wood that would never have made good lumber or pulp.

The changes that have come and that are coming stem from the work of foresters combined with that of chemists. Papermaking, until recently a craft or an art, is now a science and all manufacturing problems are met scientifically. Today pulp and paper is a chemical industry and likely to become increasingly so.

Engineers and chemists are now able to modify the manufacturing process to meet most of the physical differences occurring in the fibers of various wood species. Hence, an increased amount of poplar is finding its way into the manufacture of newsprint. Ultimately, pulp and paper foresters will be less concerned with their present problems and will be able to center their attention on increasing the productivity of the forests they administer.

Meantime, the number of cubic feet of wood actually grown in the 1951–52 wood year on the industry's woodlands exceeded the cut plus losses by fire, insects, and disease. Moreover, the 1951–52 cut established an all-time record. The pulpwood harvested this year from company limits will be some 30% lower than a year ago. Thus progress is being made carrying out the industry's forest policy which is not only perpetual yield, but an increasing yield from the forest acreage.

Finnish Sulphate (1951)

The highest sulphate cellulose production and export figures for Finland were reached in 1951 when output of unbleached sulphate totaled 564,000 and exports 390,000 tons. The next highest production figure, 562,000 tons including 68,000 tons of bleached sulphate, was achieved in 1938; the next highest export figure was that for 1949, 386,000 tons in all, of which 76,000 tons was bleached sulphate.

The largest buyers in 1951 were England 156,000 tons, the United States 69,000 tons, Western Germany 47,000 tons, France 39,000 tons, Argentina 15,000 tons and Australia 15,000 tons.

Sulphate exports during the first three quarters of 1952 totaled 161,000 tons against 283,000 tons for the corresponding period last year. Output has contracted in conformity with exports.

Domestic sales of sulphate have advanced from 14,000 tons in 1939 to 26,000 tons in 1951. In 1951 the mills continued to use 147,000 tons for processing whereas consumption in 1939 was 70,000 tons.

Although appreciable productive capacity was lost in the territorial cessions under the Peace Treaty and, further, two antiquated mills have ceased operation, output attained its peak level in 1951. This was possible for the reason that the new mills constructed immediately before the war had not yet reached their full production capacity at that time.

In 1951 the production of sulphate by-products aggregated 4000 tons of raw turpentine and 17,000 tons of crude tall oil.

The bleaching capacity lost by the Finnish sulphate industry in connection with the territorial cessions has not yet been made good. Oulu Osakeyhtiö, which in 1951 held the European record for sulphate production is building a bleaching plant with a bleaching capacity of 45,000–50,000 tons. They are now already manufacturing semibleached sulphate pulp for export.

Sulphate cellulose was manufactured in 1951 by

Enso-Gutzeit Osakeyhtiö	
Kaukopää mill	116,000 tons
Kotka mill	69,000 tons
Joutseno-Pulp Osakeyhtiö	18,000 tons
Aktiebolaget Kemi Osakeyhtiö	59,000 tons
Lohja-Kotka Oy	17,000 tons
Oulu Osakeyhtiö	124,000 tons
W. Rosenlew & Co. Ab	37,000 tons
Sunila Osakeyhtiö	89,000 tons
Yhtyneet Paperitehtaat Oy	
Walkiakoski mill	35,000 tons
Total	564,000 tons

Sweden

Swedish exports of wood pulp to the United States in 1952 probably exceeded 150,000 tons, compared with 195,000 tons in 1951 and about 300,000 tons a year in 1948–50.

Bowaters Southern Paper Corp.

History

As early as 1947 the Bowater organization started a general survey with a view to ascertaining the most suitable location for a newsprint mill in the United States. This survey indicated that there is an abundant supply of wood suited to their purpose in the southern area of the United States. In January, 1951, J. E. Sirrine Co., engineers, of Greenville S. C., were retained to make more detailed studies of several sites in the south, which culminated in the Bowater organization selecting a location on the Hiwasse River at Calhoun, McMinn County, Tenn.; the site being served by the Southern Railway System.

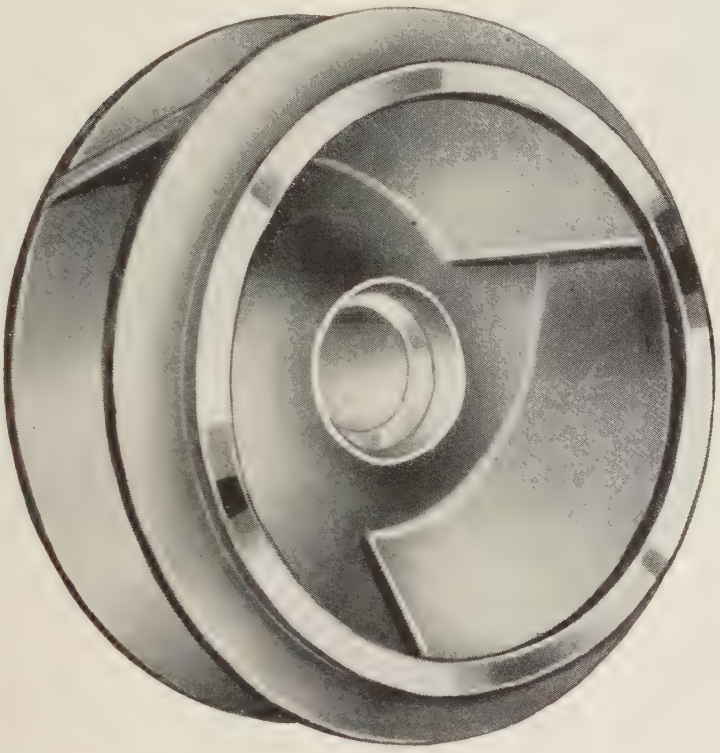
This location is situated near important coal fields and has a natural gas line nearby. It also offers the facilities for obtaining a large block of power from the Tennessee Valley Authority.

The Bowater organization filed application for a Certificate of Necessity on May 25, 1951, which was approved Feb. 19, 1952, and immediately thereafter the J. E. Sirrine Co. was authorized to proceed with the final design plans and arrange for purchase of equipment, site preparation, and construction contracts.

"Buffalo"

Tips on Better Pumping

Below, "Buffalo" non-clogging enclosed impeller of a type to be found in many "Buffalo" Paper Stock Pumps.



ADVANTAGES OF ENCLOSED NON-CLOGGING IMPELLERS OVER OPEN TYPES FOR PAPER STOCKS

1 FREEDOM FROM WEAR AND WEDGING

Note in the above impeller that vanes are shrouded. No wearing plates or close running tolerances are required, thus, there is little possibility of wedging or wear, even with high consistency stocks.

2 NO LOSS IN EFFICIENCY

Since the enclosed impeller does not depend on close running tolerances for its high efficiency (unlike open type impellers), initial high efficiency is retained indefinitely.

3 LOW UPKEEP

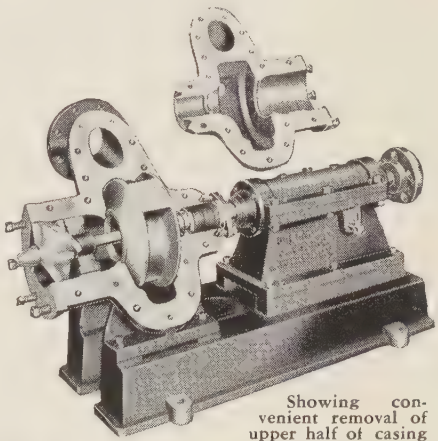
High-consistency stocks pass through as easily as through pipe. Freedom from clogging means low upkeep.

4 GREATER STRENGTH

Enclosed impellers like the one above, being shrouded, have greater strength to resist the shocks incident to paper service than open impellers. Note the sturdy design of the "Buffalo" impeller shown.

5 LOW COST STOCK PUMPING

The Diagonally Split-Shell Pump at right is one of many "Buffalo" types to give you low-cost service on any stock. Have us mail you Bulletin 953, with the engineering details.



Showing convenient removal of upper half of casing for easy servicing.

"Buffalo" PUMPS, INC.

528 BROADWAY BUFFALO, N. Y.

Subsidiary of Buffalo Forge Company

Canada Pumps, Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

Architect's drawing of the new Bowaters Southern Paper Corp. mill being erected at Calhoun, Tenn.

Surveys were made for the acquisition of land, the site taking in approximately 1400 acres, much of which was obtained from the TVA; and negotiations for a power contract were entered into with the TVA for supplying approximately 17,000 kw.

On June 14, 1952, a contract was entered into with the Oman Construction Co. for the general grading, which amounted to about one and one-half million cubic yards. Grading started in June of 1952 and was practically completed by October.

Contract was let to the Raymond Concrete Pile Co. on on June 27, 1952, for approximately 7200 piles, and the first pile was driven on September 10.

Contracts were also let in August to the Southern Railway System for track material; to A. G. Penuel for temporary construction buildings; and to T. U. Parks for the foundations of the temporary buildings.

On Aug. 5, 1952, a general construction contract for the project as a whole was awarded to Fraser-Brace and Roane Anderson companies as joint venturers; and at about the same time contracts were also let to Bethlehem for the steel requirements, and to Grinnell Co. for the piping.

Associated with J. E. Sirrine Co. will be Celli-Flynn of McKeesport, Pa., for the preparation of the architectural treatment of the mill and the design of the facilities building; also Willie Saint-Laurent of Montreal, Canada, will assist as a consultant in respect to the wood handling.

The immediate personnel of the Bowater organization resident in the vicinity of the site and who will supervise operations are: K. O. Elderkin, General Manager; V. J. Sutton, Mill Manager and Assistant to the General Manager; C. E. Opdyke, Comptroller and Treasurer; D. W. Timmis, Secretary and Assistant Treasurer; A. W. Bentley, Woodlands Consultant; George R. Koons, Manager of Industrial Relations; R. B. Reid, Purchasing Agent; and M. J. Osborne, Electrical Engineer.

The officers of the company are: Sir Eric V. Bowater, President; A. B. Meyer, Vice-President; K. O. Elderkin, Vice-President; C. E. Opdyke, Comptroller and Treasurer; D. W. Timmis, Secretary and Assistant Treasurer.

It is expected that the mill will go into operation some time in 1954.

Capacity

The initial design capacity has been made for the production of 125,000 tons of newsprint per year, and 50,000 tons annually of either unbleached or bleached kraft pulp for sale.

The newsprint furnish will require daily approximately 360 tons of pine groundwood and 120 tons of bleached kraft pulp, with the total kraft pulp requirements, including that for sale, being approximately 312 daily tons.

The chemical consumption generally will require per day approximately 20 tons of salt cake, 10 tons of caustic, and from 8 to 18 tons of chlorine, and 16 tons of lime. For the news furnish 5400 gallons of 36 Baumé liquid alum will be used, and 1200 gallons for water treatment, with required quantities of sulphuric acid and other chemicals for slime prevention, color, etc.

The plant will employ approximately 800 workers, and several hundred more for the supply of pulpwood. Approximately three and one-half million dollars will be paid annually for wages at the plant, and a similar amount—or more—in connection with the wood supply.

Wood Handling and Preparation

A total volume of 906 cords of pine per day will be used, shipped by river barge, railway, and trucks. Unloading of these carriers will be accomplished as follows:

Adjacent to and parallel with the river bank there will be unloading facilities consisting of a dock, a crane runway, a wood receiving pit, a railway siding equipped with track retarders, a truckway on the opposite side of the pit from the siding, and a second crane runway between the pit and the truckway. The siding will be graded so that an operator in the unloading area can move pulpwood cars past the pit as desired through the use of the track retarders. Unloading of each type of vehicle will be a slightly different operation, but in each case use will be made of Thew-Lorain 820-J crawler cranes equipped with either wood grapples or hooks for lifting slings.

Wood will be lifted from barges with crane-and-grapple and placed in the pit, while wood from railway cars will be pushed into the pit or handled by crawler crane in slings or by grapple to the barker feed table. Unloading to pit will be accomplished by a special bulldozer or crane-mounted pulpwood rake.

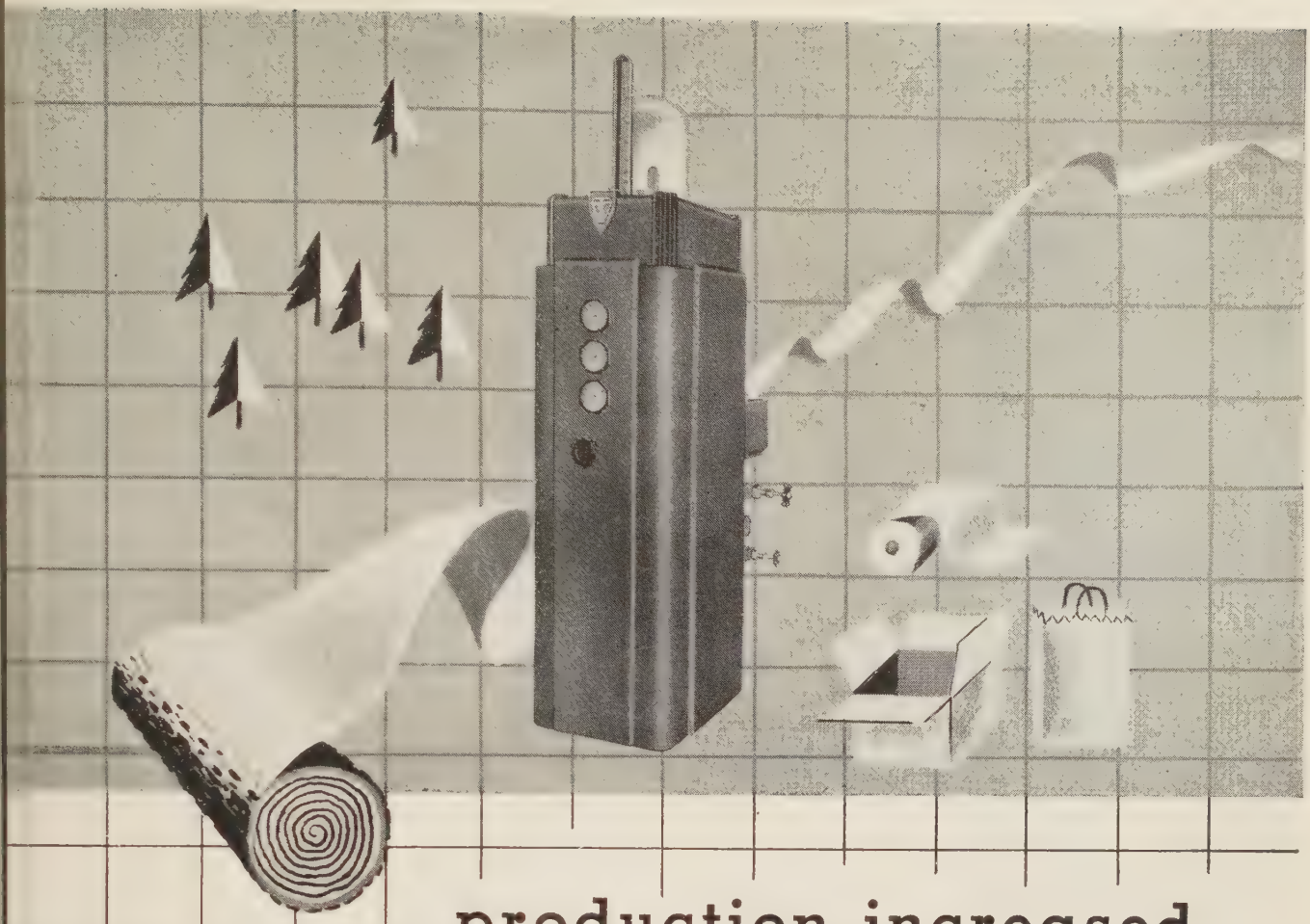
Wood arriving on trucks, not in slings, will be dumped or manually unloaded into the pit. Wood contained in slings will be placed directly on a receiving chute which will be a part of the equipment feeding the barking drums.

All wood previously placed in the pit and not handled by slings or grapple direct will be rehandled by crane-and-grapple onto a receiving chute located inside a revolving, elevated turntable which will be used for final sorting of species and for feeding wood selectively to all or any of the three barking drums. This turnable, a flat ring in shape, will be 60 ft. in diameter and 7 ft. wide, and will run continuously. Removal of wood from the table to the barking drum feed chutes will be by means of mechanically operated, remote controlled blades.

Three Fiber-Making Processes' barking drums, each 12 ft. in diameter by 45 ft. long, will be used. Dry method of barking will be used, with the bark being removed by means of belt conveyors.

Wood will be fed from the barking drums to two parallel cable conveyors which will run from the drums through the woodroom, to the center of a duplex storage pond. These conveyors will have a figure eight arrangement in elevation so that wood loaded onto the lower strand at the drums will arrive at the pond center on the top strand, and wood recovered from the pond and reloaded onto the conveyor will start on the lower strand and arrive at the top floor of the woodroom on the top strand. The duplicate arrangement of the pond and all equipment for storing and recovering wood is due to the necessity of keeping the wood prepared for the groundwood mill separate.

At the pond center wood will be dumped from the cable conveyor to a 40-ft. diameter turntable, and thence will be scraped onto a revolving stacking conveyor of special design which will place the wood in a semicircular pile having a central radium approximately half that of the pond. The pond itself will have a total volume under water for 30,000 cords. The recovery of wood from the pond will be by means of



production increased up to 15 tons per day...

. . . with W & T chlorination equipment

A Southern mill had been having trouble with paper breaks attributable to the presence of slime in their white water. Despite continued efforts to control them slime breaks were running 60 to 80 per week, resulting in a time loss of 10 to 14 hours per week, and an average production loss of 15 tons per day! It was then that the W&T man was called in.
Where and how to apply the proper treatment was determined, the costly methods were discontinued, and W&T chlorination was installed.

During the first 3 days of chlorination the mill recorded only 1 slime break and 2 minutes of lost time.

During the next 3 days there were 4 breaks and 17 minutes of lost time.

During the next 25 days there were no breaks attributable to slime!

. . . Within a week there were no production losses caused by slime!
Performance such as that is typical of what your W&T representative can do for you.

If you have a production problem attributable to impure water, it would pay you to write or call him now.

WALLACE & TIERNAN
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I-42

duplicate pivoted gantry cranes, each equipped with a hoist, trolley, and special pulpwood grapple. Wood will be placed by these cranes onto chutes at the center of the pond turntables, from which it will be scraped off onto the lower strand of the appropriate cable conveyor. In addition to conveying the wood from drums to pond and from pond to woodroom, the cable conveyors will serve as washing flumes to insure removal of residual bark and grit both prior to storing and upon removal from storage.

Wood will arrive at the top floor of the woodroom on the two cable conveyors. Both conveyors will unload onto a 40-ft. diameter turntable but at different points on the circumference so that wood for mechanical pulp can be scraped off into a butting saw, and wood for chemical pulp can be scraped off into the chipper chute. The former operation will be the first in the sequence, so that logs unfit for mechanical pulp can be allowed to pass onto the chipper feed point. Logs for mechanical pulp having passed through the butting saw will fall into a chute feeding a 1900-ft. long flume, which will carry them to the grinder room where they will be elevated from the flume to the apron conveyor feeding the grinders by means of two chain conveyors; the first of a special design for removing logs from water, the second to accelerate the logs and insure proper feeding to the apron conveyor.

Wood for chemical pulp having passed through the chipper will be fed from a surge bin to a pair of Rotex screens placed directly underneath. There will be no conveyors from chipper to screens, and a uniform feed will be accomplished by means of star feeders. Oversize chips will fall into a rechipper which will blow them back to the surge bin. Fines will be carried by a bolt conveyor to a hog which will also receive the waste from the butting saw and the dry bark from the barking drums. After hogging, all of this refuse will go by conveyors past an emergency outdoor storage point to the power plant, where it will be burned in a refuse boiler.

Accepted chips from the chip screens will be carried by a belt conveyor to the chip silos, where distribution into the three silos will be accomplished by an enclosed scraper conveyor. Removal of the chips from the silos will be by means of rotary plate feeders which will discharge onto the first of two belt conveyors carrying the chips to the digesters. This conveyor will carry the chips over a weighing device adjacent to the silos, and will discharge at the upper floor of the digester building onto a second belt conveyor, which will be equipped with a tripper for feeding the digesters.

Digesters

For the daily production of 312 tons of raw kraft, five Chicago Bridge & Iron digesters, 11 ft. 6 in. i.d. by 43 ft. 3 in., of 3300 cu. ft. capacity are being provided; with space left in the building for a sixth. These digesters are to be of A-285 Grade "B" fire box steel and built in accordance with Paragraph U-200 of the 1949 ASME Code. Some additional thickness of shell has been provided to resist corrosion. Each digester will have a shell thickness of 2 in., and weigh approximately 62 tons. The digesters will discharge through electrically operated Yarnall-Waring blow valves through individual blow lines to a blow tank having a capacity for three blows.

The blow steam, after passing through a special cyclone in the head of the blow tank, will go to an accumulator tank and Foster Wheeler blow steam recovery system for provision of hot water.

The relief steam from the digesters will be carried to a relief cyclone, condenser, and decanter furnished by Foster Wheeler for the recovery of turpentine.

Wash Room

The stock from the blow tank passes through a specially designed tramp iron trap with magnetic separator to preknotters and through three 8 by 16-ft. vacuum type washers furnished by Improved Paper Machinery Corp. Space has been left in the washer building for the addition of a fourth washer in the future. The accepted stock from the final washer will be delivered by conveyor to a high density steel storage tank of 100 tons capacity, with dilution nozzles and agitators at the bottom furnished by IMPCO for the removal of the stock at 3%.

The drop legs from the washers will discharge to a weak liquor tank 30 ft. diameter by 35 ft.; an intermediate tank 32 by 35 ft.; and a strong tank 34 by 35 ft. Three black liquor tanks, 25 by 30 ft., will be provided for storage. Foam lines from the liquor tanks will go through a foam breaker and tower, 15 ft. diameter by 60 ft. This tower will also be connected to the strong black liquor tank through a screw conveyor to a skimmer.

The rejects from the preknotters will discharge by gravity into a black liquor measuring tank, 9 ft. 6 in. diameter by 20 ft. high; provided with an agitator and a Fairbanks-Morse pump so that the knots will be returned to the digester with the black liquor fill. White liquor for the digesters will be obtained by gravity from a tank 9 ft. 6 in. by 20 ft. set above the digester room floor, receiving its supply from the recausticizing plant.

The washers, which will be mounted on the same floor level as the digesters, will be provided with hoods and exhaust fans by J. O. Ross Engineering Corp.; and the building will be served by a 15-ton hand-operated Manning, Maxwell & Moore crane.

Screen Room

The washed stock from the high density storage tank will be pumped to a surge tank at ground level, from whence the stock will be delivered through a regulator and mixing tank to two primary Mark "A" Cowan centrifugal screens; the accepted stock from which will discharge by gravity to two 9 ft. 6 in. by 10-ft. valveless type IMPCO thickeners, and thence into a screened stock chest. The rejects from these primary screens will discharge into a tank 8 by 18 ft., from whence they will be pumped to another regulator and mix tank to a Cowan Junior secondary screen; the accepted stock from which will discharge into a tank, 8 by 18 ft. The tailings from the secondary screen will go to a secondary rejects tank, 8 by 18 ft.; from whence they will be pumped through a drainer and refiner by Sprout-Waldron to a primary rejects tank for recirculation and rescreening in the secondary system.

The screens and equipment will all be located below the wash room operating floor in the same building.

Bleach Plant

From the screened stock chest in the wash room basement, as much pulp as it is desired to bleach will be pumped at regulated consistency through an E. D. Jones brushing jordan to a tonnage control unit serving the chlorinators of a 3-stage bleach plant, with IMPCO equipment.

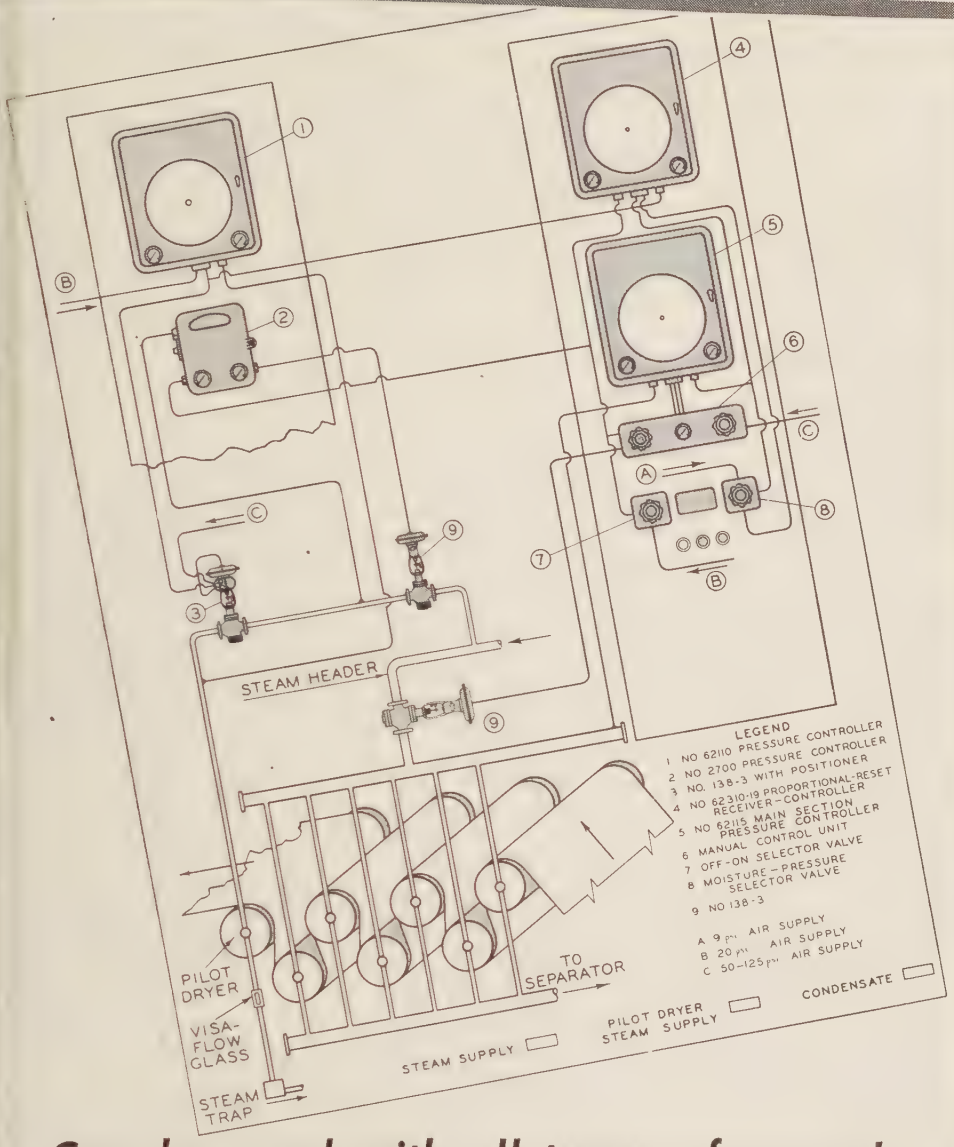
The chlorination stage will consist of a tile-lined steel tower, 18 ft. diameter by 61 ft. high, with two-tier arrangement of rubber-lined steel circulators and a rubber-covered skimmer to the launder at the top of the tower.

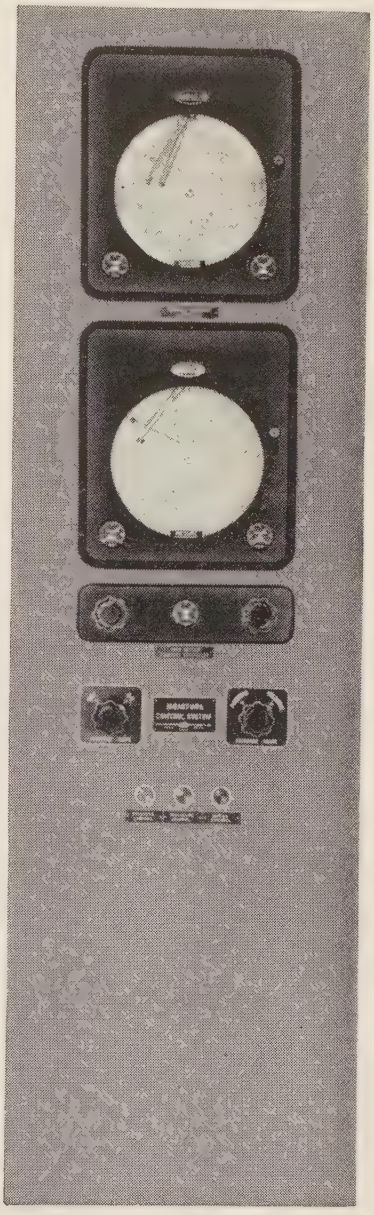
Chlorinated stock will be pumped to an 8 by 14-ft. IMPCO rubber-covered single valve vacuum washer, with shredder and conveyor for discharging through the high density double shaft mixer of cast iron to a caustic extraction tower of unlined steel, 10 ft. diameter by 47 ft. high; with one circulator of cast iron and 304 stainless steel construction.

Stock at the bottom of the caustic tower will be diluted to about $2^1/_2\%$ consistency by nozzles for pumping to a cast-iron single valve vacuum washer with shredder and conveyor for delivery at high consistency through a double shaft mixer to a steel, tile-lined hypochlorite tower, 17 ft. diameter by 17 ft. high, provided, with two 304 stainless steel circulators.

At the bottom of the hypochlorite tower, the high density

Versatile NEW MOISTURE CONTROL SYSTEM





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Extremely sensitive yet stable, this new Masoneilan Moisture Control System offers many unique advantages for improved paper-making:

Maintains average moisture content across the sheet. Does not rely on 'spot' measurements.

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stock will be diluted by nozzles and pumped to an 8 by 14-ft. final vacuum washer with rubber-covered repulper, this washer being arranged for use with a future SO_2 stage should the bleach plant be expanded.

Stock from the final washer will be delivered into a tile-lined steel vertical storage tower, 34 ft. diameter by 42 ft.; for low consistency storage, from whence it can be pumped either to the newsprint mill or to the pulp dryer for sale as desired.

The meter box, washer vats, and seal pits will all be of structural tile construction.

The seal boxes will be located on the mezzanine floor, with all of the pumps by Allis-Chalmers for both stock and white water located in the basement.

The upper part of the building from the washer floor up will be totally enclosed, well pressurized to eliminate corrosion, with exhaust fans for the removal of vapors from the washers and towers. Filtered air will be provided for air sweeping the instruments, motors, controls, etc.

The building will have an elevator serving from the basement to the three upper floor levels, giving at the same time access to the unbleached washer and digester room floors.

Discharge from the chlorination and caustic stages will be carried to a tile foam tower, which will receive also exhaust fumes and foam from the seal pits.

A glassed-in partition on the operating floor will enclose the control instruments, test laboratory, and office.

While the immediate plant will be 3-stage only for semi-bleach, full provision has been made for adding another caustic, hypochlorite, and SO_2 stage or for chlorine dioxide should the mill desire to manufacture full bleach.

Pulp Drier

For the drying of the unbleached or bleached pulp for sale, a combination IMPCO high density feltless wet machine and a Ross hot air drier will be used.

The wet machine will be of the 2-press type with vacuum forming cylinder 8 ft. diameter by 156 in. face and three air-loaded press rolls. The first main press will have a grooved cast-iron top roll and bottom roll, which will be followed by a 2-drum drier section, 60 in. di meter, and a second press similar to the first.

The Ross drier built to trim 156 in., will receive the pulp from the second press, with pinch rolls to feed it into the upper section of the drier which will be divided into nine passes, with the exit at the bottom. Forty Axiflo fans will supply the necessary air circulation, with the heaters of the extended surface type and copper tubes.

The fresh air intake to the drier will have filters to purify the make-up air and fans will also be provided for cooling the vestibules. One 14-section Ross economizer arranged for double-stage effect will be mounted on the roof over the drier and will supply some water heating.

The wet machine and the conveyors of the pulp drier will be driven by direct-current motors, with the several sections synchronized and receiving their current from a single motor generator set.

Equipment for cutting, laying, and conveying the pulp as furnished by Lamb Grays Harbor will consist of a heavy duty cutter, arranged to furnish from a 156-in. nominal trim five pulp sheets, $31\frac{1}{4}$ by $25\frac{1}{2}$ in., and three 47 by 53-in. wrappers; the cutter being driven by a direct-current motor in conjunction with the drier. Pulp coming from the cutter will be delivered to the layboy of the heavy duty type, with the sheets carried on a series of narrow belts. The sheets will be ejected from the tape unit to form vertical stacks, accumulated on the belt conveyor and lowering table. When the requisite number of sheets has been accumulated, the table will lower to its bottom position and discharge the stacks onto a conveyor, the table then raising to catch the pulp sheets accumulated during this operation on automatic fingers.

From the layboy the conveyors will carry the stacks of pulp through a single downstroke bailing press supplied by Washington Iron Works. The press platen will be grooved so that stacks of pulp can be tied in the press. The conveying system as a whole comprises a 14-ft. swing section and storage belt with wrapper pickup, an air float scale section, and a hinged roller press discharge section; with a gravity roller conveyor to a lowerator stacker which will deliver the bales to the basement onto a storage conveyor 30 ft. long.

A tile chest with a propeller type repulper will receive wet broke from the wet machine. An E. D. Jones dry pulp broke disintegrator will also be installed in the basement at the cutter to receive dry broke.

A 20-ton manually operated crane will serve the wet machine, and a small 5-ton crane the pulp cutting and handling equipment; both by Manning, Maxwell & Moore.

Storage for a minimum of 800 tons of pulp bales will be available in the basement, from whence they will be handled by lift trucks to a train shed for shipment.

Groundwood

Logs for the groundwood mill will be delivered from a water flume conveyor to inclined chain conveyors, discharging onto a flat steel apron charging conveyor to the grinders.

For preparation of groundwood, eight Great Northern Watrous grinders, complete with governors and hydraulic control equipment, will be furnished by Montague Machine Co. Each of these grinders will be driven by a 4500-hp., synchronous, General Electric motor, equipped with water coolers. Norton Co. grinder stones will be used.

There will be two 20-ton Manning, Maxwell & Moore cranes; one for servicing the grinders and the other for the grinder motors.

The motor and control room will be pressurized and a vapor exhaust system will be provided for the grinders and the grinder flumes; all ventilating work being supplied by J. O. Ross Engineering Corp.

The groundwood stock preparation equipment will consist of two Allis-Chalmers bull screens, consistency control equipment, four primary Cowan screens, and one secondary Cowan screen, supplied by Appleton Machine Co.

A Jeffrey hammermill will be used for breaking up bull screen rejects. For further treatment of these rejects and Cowan screen tailings, three Sprout-Waldron drainers and disk refiners will be provided.

Ten 12-in. primary Dirtec and ten 4-in. secondary Dirtec units are being furnished by the Bird Machine Co. for further removal of shives and dirt from the groundwood pulp. Six IMPCO groundwood deckers will thicken the stock after the Dirtecs for storage.

Stock Preparation

There will be two lines of equipment in the stock preparation room for treatment of bleached kraft pulp furnish to the paper machines; one line supplying each machine. Refining of bleached kraft pulp will be accomplished by two E. D. Jones & Sons Co.'s Royal jordans on each line. One E. D. Jones broke jordan will be provided for each paper machine, and one IMPCO vacuum saveall will clarify the white water from each paper machine.

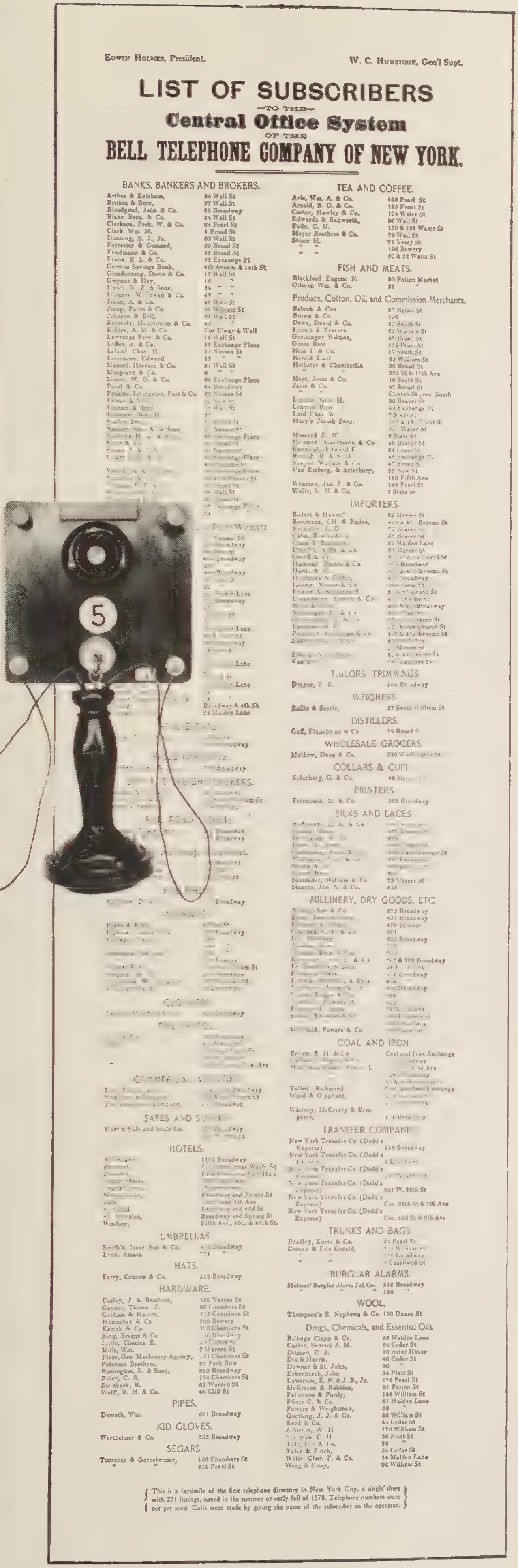
All stock and white water chests will be Stebbins' reinforced structural tile, equipped with Improved Paper Machinery Corp.'s propeller agitators.

The stock and water pumps are being supplied by Allis-Chalmers Manufacturing Co.

Metering of groundwood, bleached kraft, and broke in proper quantities will be accomplished through proportioneering equipment.

Paper Machines

Ahead of each paper machine there will be five Bird screens



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There were 271 subscribers listed in this New York directory published in 1878 . . . a group of adventurous souls who were the first to install this new-fangled device.

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Here is a measure of progress in communications and growth of population . . . duly recorded on paper. It is but one among many instances where paper has served the public interest and served it well.

In the scientific preparation of paper for its limitless number of uses, Huyck Felts play an important part. We are proud of the confidence the paper-making industry has in our product, and we find it stimulating to think of the strides still to be made.

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RENSSELAER, NEW YORK

and one flat rejects screen for final screening of stock prior to supply to the fan pump.

Two 252-in. newsprint machines, designed for speeds up to 2000 f.p.m., are being furnished by the Beloit Iron Works. Stock will be supplied to a Beloit patented crossflow distributor with a headbox and slice of latest design. The fourdrinier will have a 252-in. wide by 116-ft. long wire and will be complete with table rolls, suction boxes, and savealls of latest design for separating the wire drainage from wire shower water.

The press section will consist of automatic suction pickup roll, a suction transfer press, wringer roll, and two straight-through suction presses. The drier section will consist of fifty-five 60-in. diameter paper driers and eleven 60-in. diameter felt driers, divided into four sections. The calender stack will be Beloit open type, complete with eight rolls. The reel will be the heavy duty type, equipped with the latest design of reel brake. The winders are also being furnished by Beloit, complete with shaft puller and roll lowering table.

The newsprint machines will be driven by General Electric Co. sectional drives.

The paper machine vacuum equipment for the couch roll, suction boxes, presses, and transfer equipment will consist of three H-12A, two L-11A, and two K-10A Nash vacuum pumps.

The paper machine drier drainage system will be supplied by the Midwest-Fulton Machine Co. A Ross Grewin system will be furnished for each paper machine.

An E. D. Jones broke disintegrator will be provided at the dry end of each paper machine for handling broke and winder trim.

The wire and couch pit is of special design and wet broke from the couch will flow directly into a tile chest equipped with breaker agitation equipment. This chest will also handle the press broke delivered by a conveyor from the presses.

The paper machine will be equipped with J. O. Ross transite hood and felt drying system. The latest improvements in air make-up, heating and ventilating, motor cooling and trim conveying systems in the machine room and also the stock preparation room are being supplied by J. O. Ross Engineering Corp.

Each paper machine will have a Manning, Maxwell & Moore crane for transferring rolls from the reel to the winder, and a large machine room crane is also being supplied by Manning, Maxwell & Moore for servicing the machines proper.

Newsprint rolls will be discharged from the winder onto floor type transfer conveyors where they will be rolled into a Williams & Wilson automatic roll wrapping machine. From the roll wrapping machine the rolls will go directly to two Williams & Wilson roll header machines, each equipped with Toledo scales. Rolls then will go to an 18-hr. storage space on the second floor. A conveying system, furnished by Lamson Corp., will convey and lower rolls from this storage on the second floor to either the storage below or to a car loading conveyor running the full length of the shipping platform. The floor and platform conveyors are floor flush type and rolls can be rolled off at any desired place for loading to railroad cars by fork trucks. Storage for a minimum of 1800 tons of news rolls will be available in the basement, as well as facilities for loading trucks for local shipment.

Power Plant

To supply the steam requirements of the mill and 20,000 kw. of its electrical requirements, a topping cycle has been chosen for the power plant. Basically the plant will operate on a regenerative 2-heater cycle, with make-up varying between 20 and 50%.

Steam Generators

A careful economic study of the proper primary steam pressure and temperature to use has resulted in the selection of 875 p.s.i.g. and 825°F. One of the limiting factors in the determination of this pressure is the location of the mill in the low-cost TVA power region.

Steam at this pressure and temperature will be produced in one recovery boiler, one bark-running boiler, and two power boilers.

The Combustion Engineering recovery boiler will have a 24-hr. dry solids capacity of 950,000 lb., or an average steam production of 123,200 lb. per hour. A twin electric Western precipitator will be located at the discharge of the i.d. fan.

The Combustion Engineering bark burning boiler will be capable of producing 125,000 lb. of steam per hour, with either bark or natural gas firing. Under normal anticipated conditions there will be enough bark to maintain about a 68,000 lb. per hour steam load. Only when one of the power boilers or the recovery boiler is out of service is it intended to fire natural gas in the bark boiler for additional steam. This boiler will be equipped with a traveling grate and spreader stoker for the bark, and tangential burners for the natural gas. The boiler section will be a straight through no-baffle type.

In front of the bark boiler above the firing aisle will be a Miller-Hofft bark storage bin of 6000 cu. ft. capacity. Bark will be fed from this bin into the spreaders by screw conveyors placed across the bottom.

Each of the power boilers (provided by Combustion Engineering-Superheater, Inc.) will be of 150,000 lb. per hour capacity and will be fired primarily by natural gas, with provision for Bunker "C" fuel oil firing during periods of natural gas shortage. Under normal circumstances these boilers will share whatever load is required in excess to the bark and recovery production. In laying out the present auxiliary equipment for these units, provision has been made for the possible future addition of coal bunkers and pulverizers. The furnaces will be provided with hopper bottoms to permit the use of pulverized coal without changes to the unit proper. Soot blowers are by Diamond Specialty Co., and fans by American Blower Co.

A complete fuel oil burning system will be provided for secondary fuel operation of the power boilers. This will include a main oil storage tank, a day tank, an oil pumping and heating set, and the necessary oil guns.

Turbo-Generators

In order to obtain topping power from the process and heating steam, two General Electric turbo-generators of 10,000 kw. capacity each have been chosen.

Turbine No. 1 will have throttle conditions of 850 p.s.i.g. and 825°F. It will have automatic extraction at 50 p.s.i.g. and a Westinghouse condenser for $2^1/_2$ in. Hg.

Turbine No. 2 will be of the same throttle conditions, with automatic extraction at 150 and 50 p.s.i.g. back pressure at its exhaust.

Steam Distribution

Two steam pressure levels are needed for the mill facilities. They are 150 and 50 p.s.i.g. Extraction and exhaust steam taken from the turbines will be fed to 150 and 50-p.s.i.g. headers, respectively. From these headers steam will be taken for the mill and for whatever station service is required. Desuperheaters will be located in the mill take-offs to reduce the temperature to just above saturation.

Linking the 850, 150, and 50-p.s.i.g. headers will be lines containing PR stations. These by-pass lines are for the purpose of insuring flexibility under any foreseeable conditions.

Within the powerhouse there will also be a 5-p.s.i.g. header, with a by-pass connection from the 50-p.s.i.g. header. Steam for the No. 1 feedwater heater will be taken from the 5-p.s.i.g. header.

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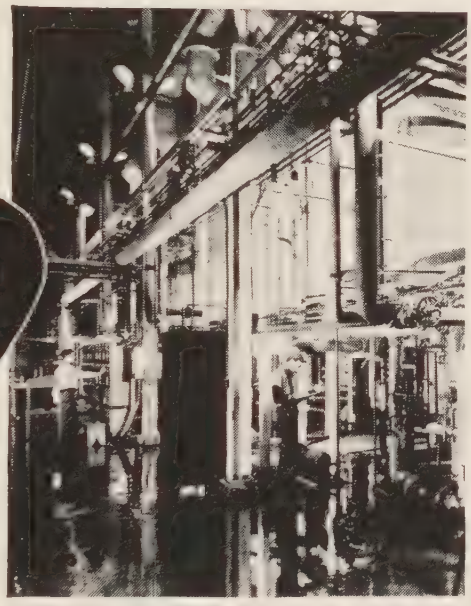

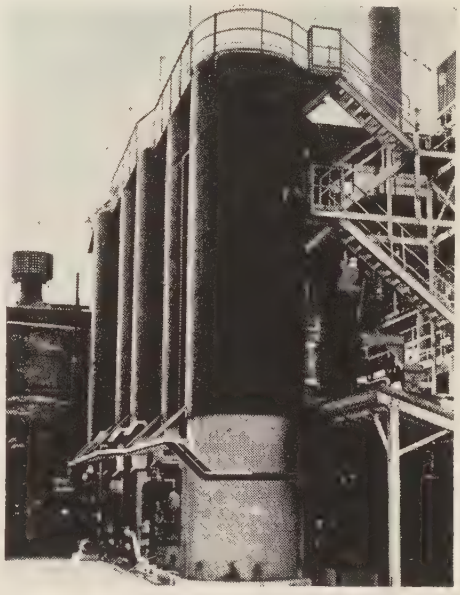

With minor design changes the Conkey Integral Evaporator is adaptable to any plant location requirement without sacrifice of its improved design and operational features. The Conkey may be set outdoors and provided with skirts making it completely self supporting. It may also be set indoors with the skirts omitted and structural steel supports added, which are provided either by the building framing or independent columns.

These advantages are found in all Conkey Integral Evaporators regardless of final job details: (1) Easier to erect. (2) Needs less space. (3) Lower overall pressure drops. (4) Larger, more efficient entrainnent separators. (5) Fewer mechanical joints to guard against air leakage.

Because its design reduces pressure drop losses between effects, the Conkey Integral Evaporator provides an increased working temperature drop across the heating element surface. Result: a net positive gain in evaporation—extra evaporating capacity. For complete technical information, write for Evaporator Bulletin.

Other General American Equipment:
Turbo-Mixers, Filters,
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Feedwater System

Make-up water will be added to the condensate storage tank along with the mill returns and condenser hot well returns. The make-up will vary between 20 and 50% of the total feedwater flow, depending on the operating conditions. Just prior to entering the condensate tank the make-up water will go through the blowdown heat exchanger.

A condensate pump (with a stand-by pump) will take water from the condensate tank and pump it to the deaerating heater which will operate at 5 p.s.i.g. This heater will be of the horizontal, tray type, capable of reducing the oxygen content to 0.005-cc./liter.

Water at approximately 228°F. will leave a Graver Water Conditioning Corp. deaerating heater and will fall to the boiler feed pumps. The feedwater pump will raise the water pressure to approximatly 1080 p.s.i., which will be sufficient to carry the water through the No. 2 heater (Lummus Co., closed type), through the feedwater control valves and into the boilers.

The No. 2 heater will receive steam from the 50 p.s.i.g. header in order to heat the feedwater to 280°F. The condensate from this closed heater will be discharged directly into the open heater.

The feed pump station will consist of three Ingersoll-Rand identical pumps, each rated at 1200 g.p.m. and 2500-ft. head. The principal pump will be driven by a steam turbine and an electric motor. The other pumps will be motor driven only and intended for stand-by service.

The turbine drive for the feed pump will receive steam from the 150-p.s.i.g. header and discharge it to the 5-p.s.i.g. header, which in turn will supply steam to the open heater. A back pressure regulator will control the flow of steam to the turbine, which varies the amount of pump load that the turbine can handle.

To keep the pump up to speed, the motor connected to the other extended shaft of the pump will take up the remainder of the load. Normally, this motor drive will be lightly loaded or just floating on the shaft, but whenever the flow of steam falls below that required for full pump power, the motor will pick up load.

The feedwater flow will include that which is necessary for steam production, plus approximately 1% for continuous blowdown. The blowdown will be flashed in two tanks, one at 150 p.s.i.g. and the other at 50 p.s.i.g. This flash steam will be piped into the corresponding headers.

Air Compressors

To supply mill and station compressed air, two Ingersoll-Rand compressors will be installed. One of these will be in the turbine room and the other in the mill. These compressors will operate at approximately 110 p.s.i.g. and supply all of the plant's service air requirements.

A recovery air compressor will be located in the turbine room for use by the recovery boiler air soot blowers. This compressor will discharge at 350 p.s.i.g. and have a storage tank of suitable volume to permit full extension and retraction of any one of the IR blowers.

For instrumentation air, one instrument air compressor will be located in the turbine room and another in the mill. The two compressor receivers will be joined by a suitable pipe so that they will both be available for either mill or power instrument use. On the outlet connections of these receivers will be air driers. The instrument air compressors will be of the "carbon ring" type so as to not introduce oil into this system.

Controls

The control of the recovery boiler will be essentially manual with the exception of a furnace draft control which will operate the induced draft fan hydraulic coupling. The rapping cycle of the electric precipitator will be automatically controlled.

The bark boiler will be fired by manually controlling the feeder screws. An oxygen transmitter will be used to control the amount of overfire air, and a furnace draft transmitter will control the induced draft damper.

In addition to the above controls the bark boiler will have air flow-gas flow controls for the firing of natural gas from the tangential burners.

The power boilers will be primarily controlled by a steam pressure transmitter which will be operated by main steam header pressure. This will enable the power boilers to produce whatever steam is required above the production of the recovery and bark units.

The power boilers will have automatic controls for the firing of either natural gas or Bunker "C" fuel oil.

All of the steam generators in the plant will have automatic three-element feedwater controls.

All automatic controls can be operated manually when required.

Electrical Equipment

It is estimated the total electrical load under normal operating conditions will approximate 37,000 kw. with approximately 17,000 kw. supplied from the TVA system, and 20,000 kw. from the mill turbo-generators. Of the total kw. load, approximately 20,000 kw. will be utilized in the wood grinding operations.

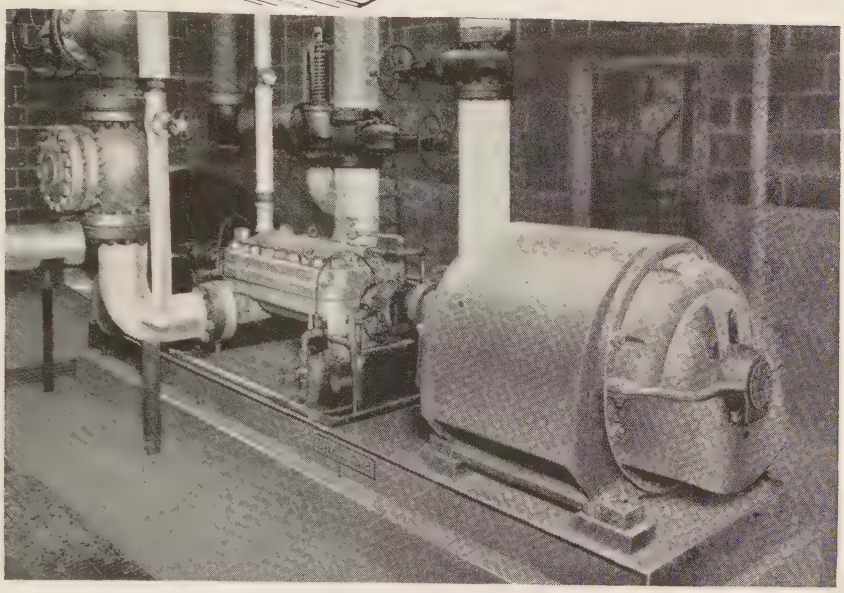
Electric power will be supplied at 13,800 volts, 3 phase, 60 cycle, and distributed throughout the plant to unit substations for conversion to utilization voltages. In general 460 volts will be used for motors up to 200 hp. capacity, 2300 volts for motors from 200 to 1000 hp., and 4160 volts for the 4500-hp. grinder motors.

The primary distribution system will consist of two principal elements, with an interconnecting tie circuit. One element, to be supplied from the TVA system, will serve the groundwood area in which will be located two 15,000 kva., 3-phase transformers and two 750-kva. unit substations for power supply to eight 4500 hp. unity power factor, 4160-volt synchronous motors to drive the grinders, together with 440-volt motors driving auxiliary equipment. The second element, which is to be supplied from two 10,000-kw. turbo-generators in the power plant, will serve the woodyard, pulp mill, bleaching, stock preparation, and paper machine areas. Each turbo-generator will be connected to a main bus from which feeder circuits to the various areas emanate. Both turbine-driven generators and the TVA system are interconnected through a synchronizing bus, with complete system control located in the power plant.

Primary control equipment has been selected on the basis of continuous current rating together with the short circuit kva. available at the point of utilization; and the whole coordinated to a 500,000-kva. level. This coordination has been extended in the selection of unit substations to permit the use of 150,000-kva. high interrupting capacity motor starters for the 2300-volt motors, and combination magnetic starters in motor control centers for the 440-volt motors. With one or two exceptions, the unit substations have thus been limited in capacity to 3000 and 750 kva., respectively.

Use of unit substations together with low voltage motor control centers practically eliminates any low-voltage power distribution. In the case of 2300-volt equipment, the motor starters form the low-voltage section of the substations; hence the motor leads constitute the 2300-volt wiring. For the 440-volt wiring, there are only short stub feeders to the motor control centers and the motor leads make up the balance. Local control of the motors will be by push button stations placed at the machines with the individual starters in isolated control rooms along with the unit substations.

Motor applications throughout the plant will be in general of the conventional type and will require only standard equipment. However, the grinder motors will be enclosed with



RIEGEL-CAROLINA'S NEW PULP MILL

uses I-R Boiler Feed Pumps

Two 6-Stage HMTA Pumps Help Generate Plant Power

Located on the Cape Fear River at Acme, N. C., Riegel-Carolina Corporation's new mill will produce 200 tons of bleached sulphate pulp daily in full-scale operation. Nearby timberlands in the Waccamaw forest will provide raw material to the 45-acre mill site.

7500 kw of electricity and process steam for the mill is generated on the premises in wood refuse and oil fired boilers. An Ingersoll-Rand, 6-stage Class HMTA centrifugal pump supplies 550 gpm to the boilers at 805 psig. A duplicate stand-by unit is arranged for both turbine and motor drive. Incorporating the Unit-Type rotor assembly designed for higher efficiency and greater dependability, these pumps are, like the mill they serve, completely modern in every detail.

For boiler feed pumps, and for centrifugal pumps for all types of service consult Ingersoll-Rand. Ninety years of experience and the complete line available will result in the best solution to your particular application.

Seventy other I-R Pumps handle these liquids at the Acme Mill:

- Alkaline cooking liquor
- Black liquor
- Heater condensate
- Heavy stock
- Light stock
- Bleach chemicals
- White water
- General service water

Ingersoll-Rand

Cameron Pump Division 741-10
11 Broadway, New York 4, N. Y.

APS • COMPRESSORS • CONDENSERS • DIESEL ENGINES • VACUUM EQUIPMENT • AIR AND ELECTRIC TOOLS

built-in air coolers to minimize the ventilation problems of the grinder room, and each of the paper machines will be driven with an electronically controlled adjustable speed variable voltage sectional drive, including multiple generator motor generator sets, and 500-volt d.c. adjustable speed enclosed separately ventilated section motors.

The plant lighting system will be sectionalized according to departments and locally controlled. In some areas mercury vapor-filament combination lighting will be used, and in others incandescent; selection depending upon the process, atmospheric, and structural conditions. Power for the plant lighting will be obtained from the 750-kva. unit substations of the general power system and distributed at 460 volts to the area centers where it will be transformed to 115/230 volts for the lighting units. Illumination intensities will vary in different parts, but will be commensurate with the requirements of each area.

Principal items of electrical equipment are being furnished by General Electric Co., Westinghouse Electric Corp., and Reliance Electric & Engineering Co.

Recovery

For the evaporation of the surplus black liquor from the kraft mill, a 6-body sectuple effect evaporator will be furnished by Goslin-Birmingham Manufacturing Co. The unit will have sufficient capacity to evaporate 173,000 lb. of water per hour; with 34,500 lb. per hour of steam at 35 lb. gage.

To condense the vapors from the sixth effect, a surface condenser of the vertical type will be used, and will consume 1800 g.p.m. of 70° water, with a temperature rise to 110°. The transfer pumps will be by Worthington, with all parts exposed to the liquor of Worthite; a pump to transfer soap to the fourth effect will also be provided.

The chemical recovery unit for the burning and reducing of the dry solids contained in the black liquor will be furnished by Combustion Engineering-Superheater, Inc. This unit will have capacity sufficient to burn 950,000 lb. of solids per 24 hours; with a steaming capacity of 123,200 lb. per hour at 875 p.s.i. and 825° from the feed water at 280°.

Preliminary evaporation on the unit will be through a Cascade evaporator, with wheels 14 ft. diameter by 9 ft. 6 in. face. Both forced and i.d. fans will be driven by motors, the latter having a hydraulic coupling for speed control.

For the soot blowing, an air puff system will be furnished for the collector zone and the economizer passes, consisting of sixteen heads automatically controlled for sequential operation. In addition there will also be twelve Diamond retractable soot blowers for the clearing of the screen tubes and superheater elements, all arranged for double side installation at six locations. These units will be air operated with saturated steam for the cleaning medium.

For the handling of salt cake a pneumatic system will be used to unload cars and deliver either into storage or the feed hopper of the unit.

For the recovery of salt cake and dust in the flue gases, a Western precipitator is to be furnished and installed as an integral part of the recovery building above the Cascade evaporators. The unit will consist of two Cottrell electrical precipitators enclosed within a shell structure of combined hollow tile, steel, and reinforced concrete. Each of these units will have an individual stack and will be so arranged that with one of these units down, the other can still be maintained in operation.

The recovered salt cake from the precipitator will be collected and dissolved in four wet bottom pans through which concentrated liquor will be circulated and its chemical strength built up.

Causticizing

The causticizing plant will consist of conventional green liquor clarifier, dregs washing, lime slaking, white liquor clarifier, and lime mud washing systems. The equipment for this operation has been purchased from the Dorr Co. The designed capacity is 30,200 cu. ft. per day of white liquor, with 8 lb. per cu. ft. of total alkali and 7 lb. per cu. ft. of active alkali, all expressed as Na_2O. The sulphidity is 30%. The equipment purchased can be operated up to a capacity of 38,000 cu. ft. per day. The clarifiers in this system are of the multiple tray type.

Lime Reburning

The lime reburning system will consist of a Traylor kiln, 9 by 250 ft., with four supports. At the feed end of the kiln will be located an Oliver mud filter furnished by Dorr Co. Fuel for the kiln will be natural gas obtained from a main which crosses the plant site. The lime reburning capacity required for the initial plant operation is about 80 tons per day; however, the kiln will have a capacity in excess of this amount for peak loads and future additional production.

Water Supply and Treatment

The raw water for plant uses will be obtained from the Hiwassee River about two and one-half miles above the plant site. Vertical submerged type raw water pumps will be used, three pumps being contemplated for the initial installation. These pumps will have a capacity of 6000 g.p.m. each, or a total of 18,000 g.p.m. The raw water will be pumped through 12,000 ft. of 36-in. steel pipe, lined and coated, to a treating plant located on a hill above the plant site. The treating plant will be a modern gravity type filtration plant utilizing flash mixing, mechanical flocculation, settling and rapid sand filters. The clear well for the plant will consist of an open, sloping side, concrete lined reservoir with a capacity of four million gallons.

The rated capacity of the water treatment plant is 25 million g.p.d.

The lower section of the clear water storage reservoir will be reserved for fire protection. Due to the elevation of the clear water reservoir, a gravity flow will be obtained to the mill; consequently, no service water pumps will be required at the treating plant.

Waste Disposal

The waste disposal system contemplated for the mill will consist of a pump house for elevating the process waste to a primary settling basin of 140 acres. Secondary treatment will be obtained in a large disposal reservoir with a detention capacity of approximately thirty days for the entire mill process waste. The sludge from the primary settling basin will be pumped to a permanent disposal area of 25 acres, located in a ravine on the mill property. The primary settling basin for the disposal plant will consist of an earth-lined reservoir, sloping sides, with mechanical rotary type sludge collector. The system is laid out for an addition of future units in the event the mill capacity is later increased.

Piping and Instruments

Plain black steel pipe will be used through the digester, wash room, and recovery area; also for the feedwater and hot condensate service.

In general, transite pipe will be used for all stock and white water piping after the washed stock storage chest and for the groundwood and stock furnish up to the fan pump of the paper machine. From the fan pumps to the machine and for the overflow from the screens stainless steel pipe will be used.

For the chlorination stage of the bleach plant, rubber-lined pipe will be used with Saran-lined pipe for bleaching liquor and lead for chlorine gas.

For throttling and shutoff service on stock lines, Crane stock valves will be provided. On black liquor in the washing and digesting system, lubricated plug cocks will be used.

The mill will be adequately supplied with control instruments, and in general the controls for the various divisions of

Just Like Your Fingerprints

No two water treatment problems are the same

That's why it will pay you to work with DORR.

No matter what your water treatment problem, there's no magic cure-all to help you. Each problem is different because of a number of variables . . . raw water composition, rate of flow, type of treatment involved and the end result you need. The economical solution of your problem depends upon a careful evaluation of all factors and the specification of proper equipment to do the job.

That is just why the Dorr line includes every type of unit . . . for both high-rate and conventional treatment. For a more complete picture of the many types of Dorr equipment available, ask us to send you a copy of Bulletin No. 9141. You'll find it interesting. THE DORR COMPANY, STAMFORD, CONN.

Every day, nearly 8 billion gallons of water are treated by Dorr equipment.

Color removal was the problem on this job . . . solved by the installation of Dorrco Flash Mixers, Flocculators and a Dorr Squarex Clarifier.

Better tools TODAY to meet tomorrow's demand

DORR

WORLD-WIDE RESEARCH ENGINEERING EQUIPMENT

THE DORR COMPANY • ENGINEERS • STAMFORD, CONN.

Offices, Associated Companies or Representatives in principal cities of the world.

the mill will be mounted on panels centrally located on the operating floor.

Buildings

All manufacturing buildings will conform to the following general types of construction:

Foundations will be cast in place, concrete piles, 40 ton capacity, with reinforced concrete pile caps, piers, and grade beams. Lighter structures, tanks, etc., will be placed on reinforced concrete spread footings with soil value 2500 to 3000 per sq. ft. Approximately 7200 piles will be required.

Building frames will be of structural steel, connected with high tensile strength bolts. Approximately 8000 tons will be required for buildings and major structures.

For the roof, level precast concrete slabs will be used; 20 year tar and gravel roofing, interior conductors with provision to maintain 2 in. of water on roof surface for summer insulation. Paper machine, pulp drying, and stock preparation rooms are also to have 2-in. rigid insulation.

Exterior walls of all manufacturing buildings will be red common brick, with small amount of yellow. Exterior of facilities and administration buildings will be yellow common brick, with small amount of red. Interior surface of exterior walls and all interior walls will be buff unglazed structural tile, 5 by 12 nominal size. Glazed structural tile will be used in toilets and other selected areas. Continuous belts of glass block will be used beneath eaves and wherever else required for lighting, with small vision panels at eye height at selected points. Continuous belts of adjustable aluminum louvers will be used for ventilation. Large areas of ventilated corrugated glass top hung sash will be featured in the grinder room and recovery room.

Floors will be reinforced concrete or welded steel gratings, depending on use and occupancy.

Four elevators will be provided. These will be in the recovery room, the bleach plant, the shops and stores building and the shipping and storage building.

The main manufacturing buildings will be approximately 1200 ft. long and will cover approximately six acres under roof, enclosing about thirteen million cubic feet of space. The power plant group will be approximately 200 ft. square and will cover about one acre under roof, enclosing about three million cubic feet. The highest structures will be the recovery room, approximately 115 ft. above grade, and the bleach plant about 95 ft. above grade.

The main mill buildings which face toward the highway will be treated with red brick, buff brick, and corrugated glass panels and glass block to enhance the architectural effect, with an illuminated Bowaters sign and insignia surmounting the center of this group.

General Facilities

A two-story building for shops and stores will be located on one side of the grinder and stock preparation rooms parallel to the servicing tracks. The upper floor, with about 20,000 sq. ft. will be used as the shops, and the basement with the same area for stores. At one end of this building where access is available by cranes from the machine room there will be a Farrell-Birmingham roll grinder, 42 by 280 in., provision also being made at the same point for loading out to cars by overhead crane. An 8000-lb. elevator by Southern Elevator Co. will serve this building.

Adjacent to the utilities building will be a paved parking area of approximately 300,000 sq. ft., sufficient to take care of 600 employees' cars.

Mill offices of glazed tile will mainly be located at one end of the shops and stores building, where they will be central to the mill. There will be other offices on the mezzanine floor at the finishing end of the machine room.

A laboratory 18 by 66 ft. of glazed tile will be located at one end of the stock preparation room adjacent to the main mill entrance and on the second floor.

The main utilities building of about 12,000 sq. ft. will be adjacent to the main entrance road and gate and will provide facilities for watchmen, first aid, reception room, credit union, personnel office, time and payroll offices; also a main locker room of tile with provision for 50 foremen, 650 white and 65 colored employees. Part of the utilities building will also be designed for a cafeteria, with a large conference room adjoining it.

The mill area as a whole will be enclosed with U. S. S. cyclone fencing, requiring approximately 9000 lin. ft. Over two miles of permanent roads built of 6 in. of crushed rock and ashphalt will serve the mill area.

The Southern Railway will serve the site with a spur track about 1500 ft. long from their main mill line near Calhoun to the mill gate. Approximately 18,000 ft. of track will be built inside the mill area for servicing the plant.

A complete system of underground storm drainage will be provided, with a separate sanitary system and process waste disposal as already mentioned.

Drinking fountains will be located throughout the mill, the supply being taken through a separate line from the filter plant, with provision for chlorination. There will be a separate compartment in the standpipe at the filter plant for storage of this drinking water.

For mill communication, there will be a 55-position switchboard for outside telephones; also an inter-mill and Kellogg Select-O-Phone system whereby paging is accomplished by dialing a number, the caller delivering his own message through the P.A. system.

For warehousing, five Butler buildings, each 40 by 100 ft., have been erected for permanent storage and is supplemented by five additional units for temporary construction purposes, giving a total of 40,000 sq. ft. of storage. In addition to this there will be two 40 by 100-ft. Butler buildings at the entrance road to serve as temporary Bowaters engineering and construction offices. These offices will be used by Bowaters on a semipermanent basis until their main administration building is completed.

D. G. Moon
J. E. Sirrine Co.
Greenville, S. C.

Hoberg

Hoberg Paper Mills is going ahead at once to construct here America's largest torula yeast plant at a cost of $2,500,000 in order to comply with state orders to cut sulphite pollution in the Fox River and Green Bay Wis. Full facts on the program came out as the company filed at Madison with the state Committee on Water Pollution a formal request for an extension beyond the end of this year to provide additional time required to build and equip the big antipollution project.

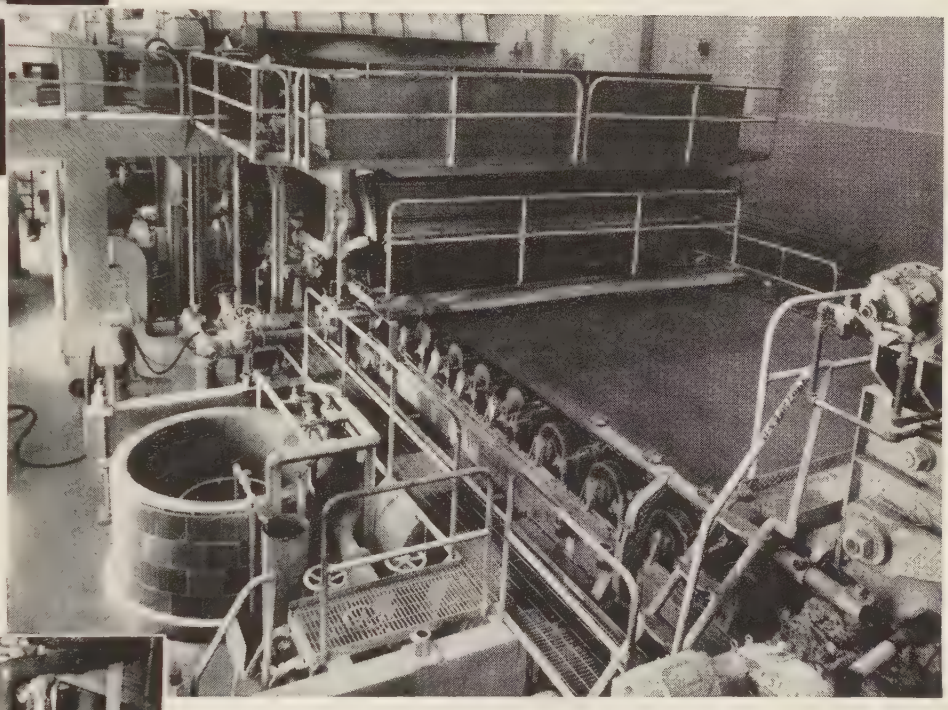
The application to the state was submitted by M. J. Auchter, Hoberg vice-president in charge of manufacturing. In it he points out that the job involves three separate phases. First, a tunnel 3200 ft. long and $6^1/_2$ ft. square must be built between the boiler plant at the company's paper division and the site of the yeast plant at the pulp division to supply steam needed for making the yeast. Second, major rebuilding must take place at the pulp mill so that spent sulphite liquor which now flows directly to the stream can be collected in strong enough concentration for efficient processing. Third, the yeast plant itself will be built and equipped for actually removing from the liquor the wood sugars, which are objectionable because they harm fish life.

"Engineering for construction is proceeding rapidly. Construction willl commence during the first quarter of 1953 and should be substantially completed by the end of the year," Auchter told the state authorities.

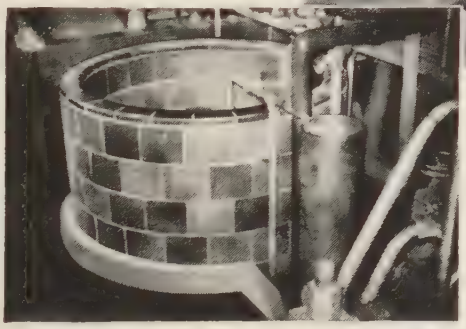
He continued, "Meanwhile we are installing at once two 125,000-gal. storage tanks which will be part of the completed liquor collection system. Until the yeast plant is in full

Another Milestone in the Art of Paper Making . . .

Hoberg's New No. 1 (178″) Yankee Fourdrinier Machine



Hoberg's new No. 1 machine. Stebbins SEMTILE Fan Pump Silo is shown in the left foreground (and in illustration below). The Wire Pit and Couch Pit are lined with Stebbins SEMPLATE. The SEMTILE Machine Chest is at the wet end of the machine.



Almost invariably, when you see a fine piece of modern paper-making equipment, like the new tissue machine at the Hoberg Paper Mills, Green Bay, Wisc., you will find Stebbins corrosion-resistant tanks and linings contributing to the quality of the product and to the profitable operation of the plant.

It will pay you to get the Stebbins man's recommendations whenever you need linings or tanks to resist acid or alkali conditions.

SINCE 1884
Specialists in Design Installation and Servicing of Linings and Tile Tanks

SEMCO

STEBBINS

Engineering and Manufacturing Company, Watertown, N. Y.

STEBBINS ENGINEERING CORP. — TEXTILE TOWER, SEATTLE, WASH.

CANADIAN STEBBINS ENGR. & MFG. CO., LTD. — CASTLE BLDG., MONTREAL, CANADA

operation, these tanks will be used to load roadbinder trucks for continuing the roadbinder program which Northern Paper Mills and Hoberg have been jointly conducting since early in 1951."

The heart of Hoberg's plant will be two "reactors," ceramic tile tanks 26 ft. in diameter and 14 ft. high, in which torula yeast organisms continuously propagate and feed on wood sugars while other plant nutrients trickle in and air is steadily bubbled through the liquor to maintain maximum rate of yeast growth. Liquor is continuously bled off from the reactors and pumped to stainless steel centrifuges which operate like cream separators to extract the microscopic yeast organisms. After washing and recentrifuging, this yeast cream goes to an ordinary milk drier and there becomes a powder resembling corn meal in appearance.

Dried torula yeast now is used principally by the animal feed industry as a vitamin supplement and in the pharmaceutical industry as a raw material. It is also a vitamin-high protein food for human beings and was used on a large scale for this purpose in Europe during World War II, but has never been marketed for this purpose in the United States.

Wisconsin already has one torula yeast plant processing spent sulphite liquor. At Rhinelander, Lake States Yeast Corp. operates a plant of approximately half the capacity that Hoberg plans. This company was formed and its plant was built in 1948 by a dozen Wisconsin sulphite mills to give a full-scale test to the process which had been originally worked out in the laboratories and pilot plant of the Sulphite Pulp Manufacturers' Research League, of which Conway also is president. More than two years ago the Lake States unit was sold to Rhinelander Paper Co., whose pulp mill it adjoins, and its technical findings remain available to the League and to all League members.

Western Michigan College

An intensive 10-day course on statistical control in the manufacture of paper is planned at Western Michigan College from June 15 to 25, it was announced recently by Alfred H. Nadelman and Charles H. Butler. Because of the nature of the problems to be handled and the time allotted, enrollment, will be limited to 50 persons.

Arrangements for this course of instruction were made through the Technical Association of the Pulp and Paper Industry, which last summer worked with the University of Maine on a similar study plan. The 1953 program will be the second conducted in the United States.

Dr. Butler, head of the mathematics department at Western is handling details for the course. Dr. Nadelman heads the pulp and paper technology curriculum. Instructors will include Dr. Fred Beeler of the WMC mathematics staff; Dr. Geoffrey Beall, University of Connecticut, and Dr. C. A. Bicking, Army Ordnance Corps, Washington D. C. A corps of eight lecturers will also augment this staff, to include W. R. Purcell, Brown Co., Berlin, N. H., and O. H. Somers, Western Printing and Lithographing Co., Racine, Wis.

Packaging Institute

The 15th annual forum of the Packaging Institute will be held at the Statler Hotel New York, N. Y., on Oct. 12–14, 1953.

Newsprint Marketing

The U. S. Dept. of Commerce has issued a 126-page book on "Transportation Factors in the Marketing of Newsprint," by Edward Margolin and William McLendon. It may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 40 cents per copy.

Paper Career

The National Paper Trade Association, 220 E. 42nd Street, New York 17, N. Y., has issued an interesting 31-page booklet "A Career in Paper." Brief articles on the subject are presented by Alexander Calder, John H. Hinman, Cola G. Parker, and Arthur W. Towne.

Wisconsin Plantings

A total of 47,322,000 trees have been planted on 628,127 acres of certified industrial forests in 28 Wisconsin counties, the Wisconsin Forest industries Information Committee reports. Of this acreage, 130,000 is owned by sawmills, the remainder by pulp and paper companies.

Industry, in cooperation with the state's counties and the Wisconsin Conservation Dept., is now conducting a forest inventory to determine the actual volume of timber on some 20,000,000 acres of private and public land.

Weyerhaeuser

In these days of critical power shortage in the Pacific Northwest, Weyerhaeuser Timber Co., is a refreshing exception—a major industrial firm that produces more electric power than it consumes.

Six Weyerhaeuser plants are interconnected electrically with the Northwest Power Pool and are delivering approximately 1,500,000 kw.-hr. per week to the pool during the current shortage, while withdrawing less than 500,000. This is a net gain to the pool of more than a million kilowatt-hours a week.

The production of power at Weyerhaeuser mills is one result of the firm's determination to use as much of the forest harvest as possible. In this instance, electrical energy is created from bark, sawdust, and other sawmill left-overs that might otherwise be wasted.

The six Weyerhaeuser mills interconnected with the Northwest Power Pool are the Everett, Wash., pulp division and Weyerhaeuser lumber-division plants at Snoqualmie, Enumclaw, Raymond, and Longview, in Wash., and Springfield, Ore.

Of these, only the Everett pulp division regularly takes energy from the pool. On an average week, before power curtailments were ordered by the Defense Electric Power Administration, the Weyerhaeuser pulp mill at Everett was using 334,000 kw.-hr. of pool energy.

Other Weyerhaeuser branches add various amounts of energy to the pool. The Snoqualmie Falls branch contributed a net gain to the pool of 179,000 kw.-hr. during a recent week, while the White River branch at Enumclaw was adding about 176,000 kw.-hr.

The firm's Willapa Harbor branch at Raymond furnishes the pool 50,000 kw.-hr. in an average week, the Longview branch generates 737,000 kw.-hr. more than it consumes per week and the Springfield branch provides the pool with 259,000 kw.-hr. in a one-week period.

Although outside the Northwest Power Pool area, Weyerhaeuser branches at Klamath Falls and Coos Bay, North Bend, Ore., are delivering substantial amounts of electricity to local power companies during the current shortage. The Klamath Falls branch furnished California-Oregon Power Co. 143,000 kw.-hr. last week for example, while the Coos Bay branch at North Bend was supplying 670,000 kw.-hr. to Mountain States Power Co.

Pacific Waxed Paper

Pacific Waxed Paper Co. of Seattle, Wash., converters of letterpress and rotogravure printed waxed paper specialties, transparent films and foils, has recently placed into operation another Dilts waxer.

This new unit, a 72-in. 3-roll waxer was built and installed by the Dilts Machine Works, Fulton, N. Y.,

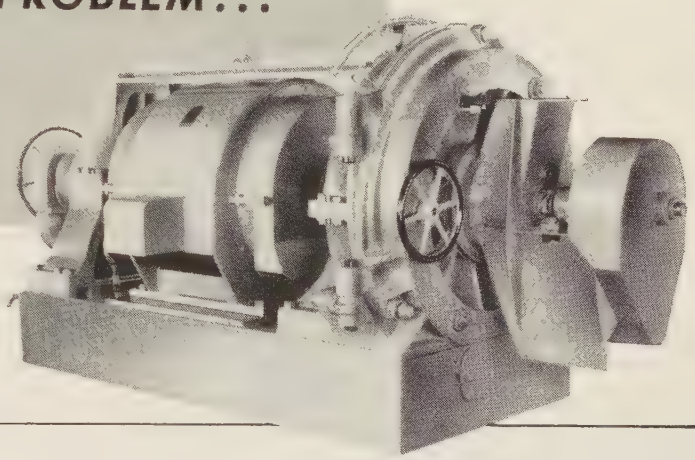
Mechanically capable of speeds to 1000 f.p.m., the machine has been in continuous operation since January, 1952. The principal products waxed have been high quality bread wraps,

Q. How do you spell **economical refining?**

A. **"S-P-R-O-U-T"**

FOR THAT PULPING PROBLEM...

GET A SPROUT!



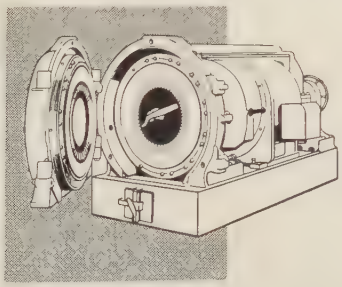
here's why:

Sprout-Waldron Refiners are chosen by *most* mills for all types of pulping and refining operations. They are the *leading producers* of semi-chemical pulp. For economical pulping and refining, choose a Sprout!

* high pulp quality
* high capacity
* flexible operation
* rugged construction

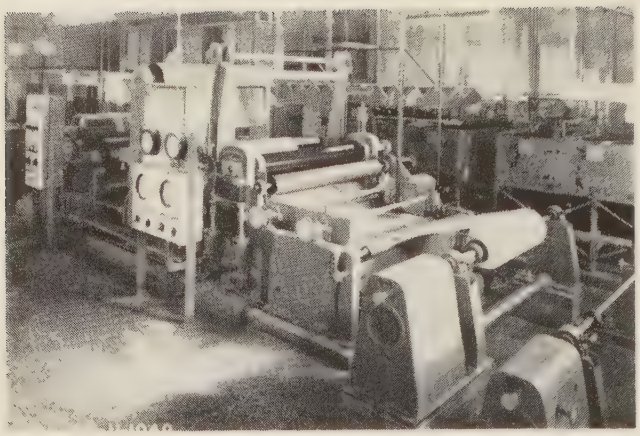
For careful analysis and specific recommendations, send your pulping problems to Sprout-Waldron. Address: Sprout-Waldron & Co., Inc., 38 Logan St., Muncy, Pa.

S W



SPROUT-WALDRON

PULP REFINERS



The Dilts waxing machine installation at Pacific Waxed Paper Co.

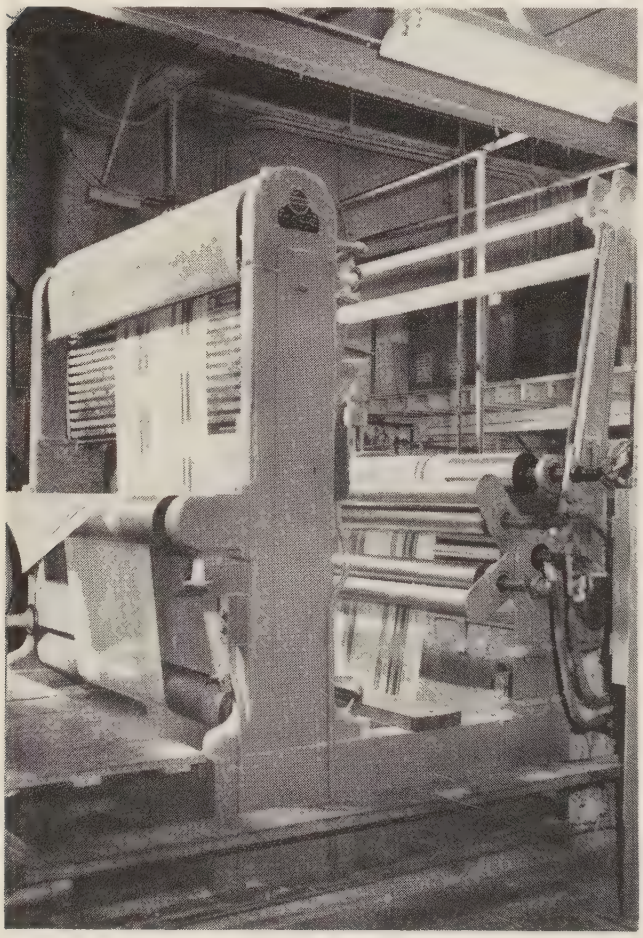
rotogravure printed frozen food wrappers, and carton overwraps.

A brief description of the installation is as follows:

Two single-position friction unwind stands having straight line quick opening bearing caps and totally enclosed air cooled friction units comprise the unwind section. Rolls up to 40 in. diameter can be handled.

The unwinding sheet passes over a 5-in. diameter steel tube squaring roll which guides the sheet entering the waxing bath.

Within the dip pan are two complete dip roll assemblies having 5-in. diameter steel tube rolls. These rolls are vertically adjustable for threading.



Dilts water finishing attachment on Pacific Waxed Paper Co.'s waxing machine

The squeeze roll section is composed of a 14-in. diameter solid chilled iron roll and two 10-in. diameter rubber-covered rolls bored for steam. Rolls are equipped with antifriction bearings and the top and middle rolls are individually air loaded.

After leaving the squeeze roll section the sheet proceeds toward the water finishing section by passing over a steam-heated 7-in. diameter lead roll which is adjustable vertically above the water bath. Next the sheet passes through a unique Dilts designed three-roll polishing section composed of 5-in. diameter steam-heated brass rolls which are driven in the opposite direction to that of the sheet. The angle of wrap, or the amount of polishing desired within the polishing section, can be adjusted during operation.

Entering the water bath the sheet passes under two dip rolls and then into the Dilts water finishing attachment which uses the knife principle for the removal of excess water picked up in the water bath.

Residual heat is removed from the sheet by two 24-in. diameter cooling drums through which refrigerant is circulated continuously.

Winding is accomplished alternately on two center-type rewind stands driven by a constant tension special duty winding motor.

This type of waxing machine is the most versatile, single-head waxing machine being built by any manufacturer today. It is possible to dip wax, wet wax, dry wax, wax laminate, and apply any desired finish by a combination of polishing, water finishing, and controlled cooling.

Air controls for roll load pressures, steam controls for individually steam heated rolls, and individual electrical controls for each section of the machine enable the operator the greatest latitude in obtaining any desired set of operating conditions. Instruments supplied with each individual control enable the operator to record the specific conditions on any one run and thereby run exact duplicates at later dates with a minimum of adjustments.

Crown Zellerbach

Crown Zellerbach Corp. has sold its new one-story paper converting plant and office building at 2000 West Avenue 137 in San Leandro, Calif., to The Mutual Life Insurance Co. of New York, it was jointly announced recently by D. S. Coney, Resident Manager of the San Leandro division of the paper company, and investment officials of the insurance company. Mutual has leased the building back to Crown Zellerbach for 25 years with the option of renewal for another 50 years. The building is the eighth to be sold to Mutual by Crown Zellerbach under similar arrangements, the others being located in Los Angeles, San Leandro, Salt Lake City, Seattle, and Sacramento.

With 300,000 sq. ft. of manufacturing, office, and warehouse space, the recently completed building houses the newest of Crown Zellerbach operations in the San Francisco Bay area.

Crown Zellerbach already operates a waxed paper plant at San Leandro. Decision to establish a second plant there was based on the rapid population and industrial growth in Northern California and the desire to better service its growing number of customers for converted products in this geographical area.

The paper the new plant uses is manufactured in the company's big Pacific Northwest pulp and paper mills and shipped to San Leandro in large rolls. There, these rolls are converted into heavy duty multiwall bags, grocery and carry bags, paper towels, paper napkins and high quality facial type and other toilet tissues. The site contains enough land to double the plant capacity when the need arises.

Nekoosa-Edwards

Nekoosa-Edwards now owns 50% of the Tomahawk Tim-

DE RIDDER, LA. PLANT

ROSIN SIZE

FF ROSIN SIZE
BEREZ ROSIN SIZE
#34 ROSIN SIZE
#28 ROSIN SIZE
#82 ROSIN SIZE

CROSBY

THE MARK OF QUALITY

Crosby Chemicals, Inc., manufacturers of wood rosin paper size—two large rosin size plants located east and west of the Mississippi which expedite the cooking and prompt shipment of rosin size—15 years' experience in the manufacture of rosin size assures you satisfaction and high quality—regular, fortified and special grades of dark rosin size, 60, 70 and 80% solids, tailormade to meet your requirements—Experienced technical service available to all accounts.

CROSBY

THE MARK OF QUALITY

WOOD ROSIN

Two large steam distilled wood naval stores plants assuring you a dependable source of rosin for size. 700 series (pale) and dark grades of paper size rosins are produced for those manufacturing their own size.

PICAYUNE, MISS. PLANT

CROSBY CHEMICALS INC.

DE RIDDER, LOUISIANA

ber Co. Nepco, along with Mosinee Paper Mills Co., had each held 45% of the timber company, while National Container Corp. owned 10%. Negotiations were recently completed for the sale of National Container's interest, with Nepco and Mosinee each acquiring 5%.

Tomahawk Timber Co. is an operating company holding agreements with the federal government for logging operations in the Superior National Forest in northern Minnesota. This timber area will in the future furnish a large part of Nepco's spruce requirements at favorable freight rates compared with other sources. The town of Forest Center, Minn., is headquarters for the logging operation. Annual output of the timber company is between 80,000 and 100,000 cords.

Rayonier

The two-way radio is now as essential a tool in producing forest products as the power saw and the tractor and bulldozer, according to Myron B. Savage, photogrammetrist and radio supervisor for Rayonier Inc. Speaking before the 43rd Annual Forestry Conference, December 10–12, in Victoria, B. C., he described the radio network which blankets the chemical cellulose producer's extensive forest holdings as a "time-saver, money-saver, property-saver, and life-saver."

According to Mr. Savage, Rayonier has divided its Northwest operations into two major geographical areas, each with its own radio network. Each area maintains approximately 40 mobile units and 4 transmitting bases. Distance and rugged mountains prevent any radio communication between the two areas.

Since the Federal Communication Commission's law demands that "the highest order of frequency shall be employed," Rayonier conducted its first propagation surveys on 150 megacycles. The area is rough and mountainous, and 150 megacycles gave only about 20% coverage, mostly with poor intelligibility. Directional antennas were impractical because the operation could not be confined to any pattern. The Andrews unipole antenna proved most efficient and was used in all surveys.

Additional surveys revealed that 49.42 megacycles gave satisfactory coverage with fully quieted signals over 80% of the area. Additional bases and permanent 75-ft. antenna towers would increase the coverage, while lowering the frequency would increase interference from distant stations.

Mr. Savage emphasized that it is more economical to increase coverage and clarify the signal by improving the antenna radiation and cleaning up the system rather than by increasing the power. An increase in signal strength on the receiving end varies with the square of the power output and the cost varies in about the same proportion.

Today mobile units are installed in Rayonier's locomotives, speeders, ambulances, safety cars, trucks, pickups, supervisors' cars, fire trucks—even in the "crummy"on the end of the trainload of logs.

As an example, Mr. Savage described moving a trainload of logs from the woods over the hump to the booming grounds. The engineer, in his cab, is in constant radio contact with the dispatcher: he moves out knowing the mainline is open; he checks for clearance at junctions ahead of time and from his moving cab instead of from a rail-side phone; he's always on tap for last-minute instructions to pick up additional cars or switch out loads. The brakeman, 80 to 100 cars to the rear, hears immediately over his handie-talkie just what's going on, instead of after a 20 to 30-minute walk forward—another time saver. The train's sustained momentum enables the engineer to pull more loads over the grade. The shop mechanic finds substantial reduction in brake shoe and wheel repair.

The radio network has reduced the average train run by an hour. Since the cost of running a train is approximately $100 per hour—figuring two trips a day, the system saves, conservatively, $200. According to Mr. Savage, six loads completely amortize the cost of the radio, and without counting increased production or reduced repair bills. Rayonier feels that if the intangibles are included, one haul might balance the cost of the mobile unit.

Industrial radio, FCC rules, must be used first in the interest of human welfare. Rayonier equipped ambulances and safety cars with 2-way radio communication. The company maintains radio contact with its most remote areas expressly to care for the sick and injured, whether they are employees, loggers, working for other outfits, or traffic victims on the public highways. Most of their calls are emergencies and radio, like blood plasma, is often vital if the patient is to live. When an ambulance races a critically ill patient against time, radio provides contacts with police and hospital: roads can be cleared; doctors alerted; life-saving equipment readied. What's more employees in remote forest sections are secure in the knowledge that, in case of accident, help is quick and efficient.

Finally, of course, the network is invaluable in case of forest fires. Preventing a fire beats fighting it, and Rayonier is proud of the fact that it can close down its entire forest operation and start the men out of the woods in a matter of seconds when humidity or fuel moisture reach the danger point This has been more than proved in the current great drouth in the Northwest.

As soon as a fire has been detected, radio speeds out the report, mobilizes fire trucks and men, and makes it possible to fight the fire more efficiently.

According to Mr. Savage, Rayonier emphasizes prevention rather than cure to maintain the system. A company radio technician regularly inspects the common breakdown points and catches trouble before it occurs. Most often the problem is dirty relay contacts, a low or corroded battery, or some minor ailment. Most critical problem is loss of voltage. Rayonier has in many instances installed Leece Neville generators on mobile units for keeping batteries in efficient operating condition.

East Texas Mill

R. A. McDonald, Chairman of Executive Committee of East Texas Pulp and Paper Co., has announed that H. A. Simons, Ltd., of Vancouver, B. C., will design and build the pulp mill to be constructed by that company at Evadale, Tex., located 15 miles north of Beaumont and 90 miles northeast of Houston.

The Simons firm has designed three other pulp and paper mills during the postwar period. The most recent Simons-designed plant, located at Duncan Bay, B. C., is the only new newsprint mill built in Canada since the war.

Work on the new plant is scheduled to get under way in April. When completed late in 1954, the mill will be equipped to produce 250 tons of bleached sulphate pulp and paperboard a day.

McDonald further stated that plans for financing the company, which is owned jointly by Houston Oil Co. of Texas and Time, Inc., publishers of *Time*, *Life*, and *Fortune*, had been completed through arrangements finalized with the Northwestern Mutual Life Insurance Co. and The Chase National Bank of New York.

Suggestions for Teachers

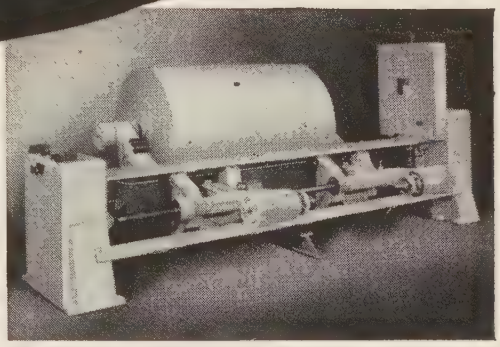
The International Paper Co., E. 42nd Street, New York 17, N. Y., has issued over a million copies of an interesting booklet "The Little Trees That Went to School." It is being distributed to schools in the South.

Gair Woodlands

Competing unsalable hardwood trees in pine forest stands on Gair Woodlands properties are poisoned. This releases young pine seedlings and trees to grow.

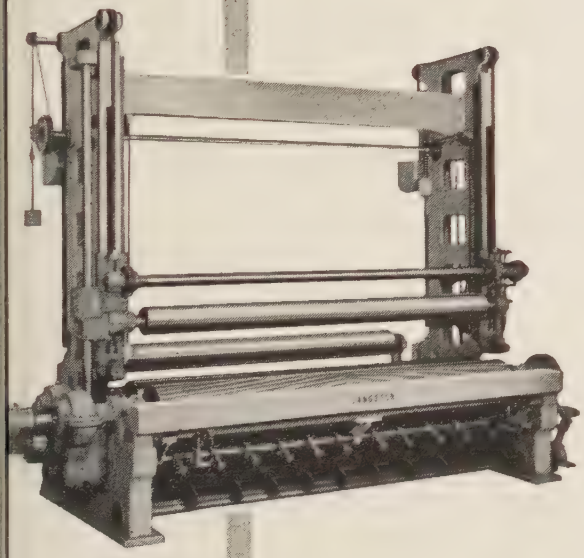
Killing hardwood trees may seem to be a waste of good wood, but since fuel oil has replaced firewood for heating and

LANGSTON SHAFTLESS *Mill Roll Stands*



Various types of Langston Mill Roll Stands are available, equipped with constant tensioning, side register control, etc. Special construction can be provided to receive customers' reels or unwinding shafts. Shaftless type, self loading Langston Mill Roll Stands also are available.

SAMUEL M. LANGSTON CO.
Camden, N. J.



Langston SLITTERS and WINDERS

cooking both on the farm, in the city, and even tobacco curing is now done with oil burners, plus the fact that oak is not a favored tree for pulpwood, upland hardwoods, of this type must be destroyed in order to grow full forest stands of valuable pine trees.

Girdling the tree with an axe tends to kill the top of the hardwood tree because it kills the growth layer. Application of the tree-killing chemical solution to the cambium, or growth layer inside the bark, completes kill of the tree top and also destroys life in the roots to prevent sprouting later. The chemical can be used in cups or notches chopped at intervals around the base of the tree, but girdling, or frilling as it is also called, is usually easier and cheaper.

This use of chemicals, poisonous to trees but noninjurious to humans or animals and applied in the form of crystals, or in solution with water or fuel oil, has only been developed during the past several years. Previously, the elimination of undesirable hardwoods in the forest had to be done by straight girdling which resulted in much sprouting and which required repeat operations, or else by using poisons dangerous to persons and to animals.

Housing Research

The Housing and Home Financing Agency has issued a 723-page book on "A Survey of Housing Research in the United States." Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at $3.00 per copy.

St. Regis

Winslow B. Mills has been appointed General Superintendent of the pulp and paper mill at Pensacola, Fla.

Winslow B. Mills, St. Regis Paper Co.

Trees planted in 1931 are being used at the St. Regis Paper Co.'s plant at Eastport, Fla.

The firm's 200,000-acre Suwanee Forest in southeast Georgia, held under a 60-year management contract, will furnish 100,000 cords a year to the new mill. An additional 75,000 will be brought in from other sources.

Bark-free sawmill slabs from the W. T. Smith Lumber Co., Chapman, Ala., will be used by the St. Regis Paper Co., Pensacola, Fla., in the manufacture of kraft pulp and paper.

The lumber company, cutting at full capacity, can supply the kraft mill with chips from the slabs which would amount to the equivalent of 18,000 cords of pulpwood annually. Officials say the chips produced from this sawmill material are equal in quality to those produced from pulpwood.

For several years St. Regis has been making use of chips from debarked sawmill slabs in its western operations.

St. Regis Paper Co. announces the acquisition of forest management and timber cutting rights for a period of 60 years on a tract of 34,200 acres of long leaf and slash pine in Worth and Turner counties, Ga., through an agreement completed with the Aultman family of Warwick, Ga.

The Aultman tract, located in the upper coastal plain of Georgia, approximately 150 miles northwest of the new St. Regis kraft pulp, paper and board mill at Jacksonville, Fla., is in an area that includes some of the finest timber producing land in the Southeastern United States.

As a result of this addition to its raw material resources, the company now has over 600,000 acres of woodlands owned or under long-term management leases in the south, of which around 300,000 acres are within a radius of 100 miles of the new Jacksonville mill. Wood from the Aultman tract can be shipped to Jacksonville, the company states, by the Southern Railway and the Seaboard Air Line Railroad.

St. Regis announces that it plans to plant two million slash pine seedlings annually during the first seven years of management.

The company has long-term management and cutting rights contracts on the Suwannee tract of 217,000 acres in Georgia and an area of 47,500 acres in Madison and Hamilton counties of Florida, known as the Gibson tract; both within a radius of 100 miles of Jacksonville.

St. Regis operates the largest privately owned seedling nursery in the South at Pensacola, Fla., where it grows at the present time some 10,000,000 seedlings annually. At the Gibson tract, the company is establishing its second southern nursery to raise some 6,000,000 seedlings a year for planting on the company's own lands and for distribution to landowners in the area in which the company operates.

St. Regis Paper Co. has announced the commencement of production by its new kraft pulp, paper, and board mill at Jacksonville, Fla., having a capacity to produce 100,000 tons of paper annually. This addition raises the company's capacity for the production of kraft paper and board to 560,000 tons a year.

The new mill, located on a 200-acre site on tidewater at Eastport, on the outskirts of Jacksonville, is served by the Seaboard and Atlantic Coast Line railroads. In making the announcement, Roy K. Ferguson, president and chairman of the company, states that the most modern manufacturing equipment has been installed, making full utilization of the company's experience gained in high volume production of kraft pulp, paper, and board in its Pensacola, Fla., and Tacoma, Wash., mills.

This mill, it is pointed out in the announcement, represents an important part of the long-range southern expansion program projected by the company that had as its aim complete integration of the Kraft Division, and in anticipation of which St. Regis acquired over the years a permanent source of wood supply in Florida, Alabama, Georgia, and Mississippi.

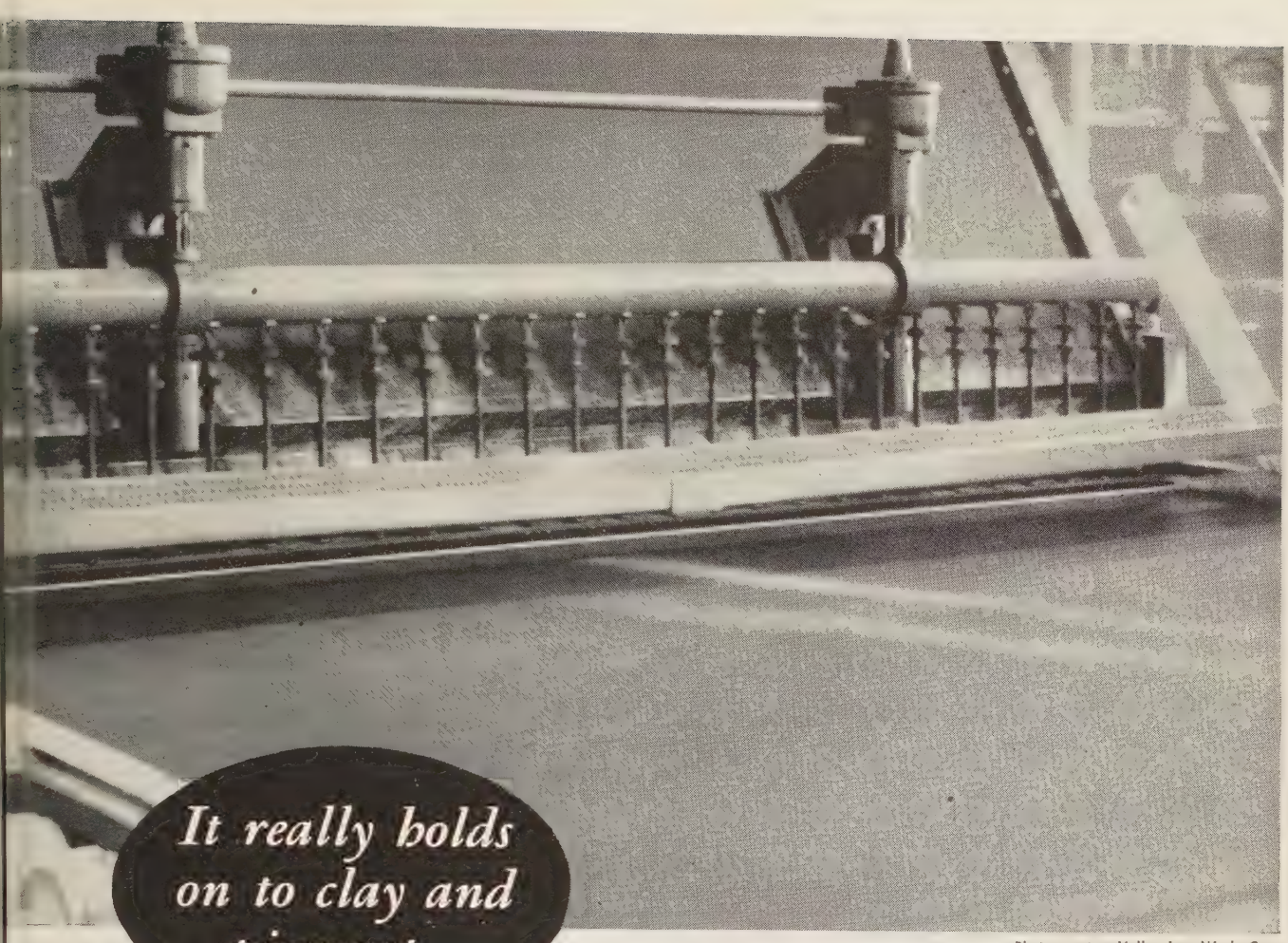
The announcement states that this new mill, capacity of which will be used principally for supplying kraft paper and board for the company's contract customers, has been planned, and key facilities installed in adequate size so that it can later be enlarged if long-term trends favor expansion.

The new mill is advantageously located in relation to pulpwood supply. The company owns or holds under long-term management contracts over 600,000 acres of timberlands in the south, of which approximately 300,000 acres are within a radius of 100 miles of Jacksonville. An adequate flow of wood will be available from these holdings and from farmers and other landowners within this area. On the basis of a capacity to produce 300 tons of kraft paper daily, the annual requirement of pulpwood for the mill is approximately 175,000 cords.

The fourdrinier paper machine at the Jacksonville mill, which was built and installed by the Beloit Iron Works, Beloit, Wis., has a wire 230 in. wide and 120 ft. long, and was designed for an ultimate speed of up to 2500 ft. a minute.

Many unique features, applied for the first time in paper mill construction, have been incorporated in the company's newest facilities at Jacksonville, from the handling of wood through to the finishing room. Close to a million dollars has been spent for installation of the most modern developments in devices and equipment to eliminate or reduce to a minimum air pollution, odors, and stream pollution.

Merritt-Chapman & Scott Corp., New York, were general contractors on construction of the mill and also directed the work of all subcontractors. Stevenson and Rubens, Seattle, Wash., carried out the engineering work on the structural and architectural design, as well as the layout and process arrangements for the paper mill. Merritt-Chapman & Scott



It really holds on to clay and pigment...

Photo courtesy Valley Iron Works Co.

One of the three big reasons why papermen prefer Swift's new process Glue

Yes, many successful book paper producers can tell of the unusually high retention of clay and titanium pigment achieved with Swift's new process Glue as flocculating agent.

Made by an exclusive process that assures a glue of exceptional purity and uniformity—Swift's new process Glue promotes greater retention of fibre and filler on the screens. Prevents the loss of valuable clays and titanium pigment in white water. Because it is a colloidally active water soluble animal protein, Swift's new process Glue helps in the even formation of the sheet.

Performance is economical, too. Works in low concentrations . . . requires no expensive agents in solution. Easy to prepare . . . easy to handle . . . non-foaming!

Check these reasons, too!

● **High Recovery in Flotation-type Save-all Systems!** Clearer effluents are obtained with Swift's new process Glue, thanks to its great ability to "flock" fibres and fillers. Economical and easy to use . . . produces consistently good results.

● **Higher Pick Test!** Swift's new process Glue is highly efficient in the production of paper that requires increased Pick Test.

As a partial replacement for starch in machine coating, it has shown greater film forming properties and tensile strength than a total starch solution.

Call **SWIFT** first for **GLUES**

SWIFT & COMPANY
Adhesive Products Department
Chicago 9, Illinois

This offer expires Mar. 31, 1953

Please send your 100-lb. introductory shipment of Swift's new process Glue at the quantity price, to be tested for use in our operations. We understand, if not fully satisfactory, it may be returned for credit at your expense.

*Name*_____ *Title*_____

*Firm Name*_____

*Address*_____

*City*_____ *Zone*____ *State*_____

provided the structural and architectural design for the pulp mill and power plant, while Johnson & Co., New York, served as consulting engineers in furnishing the design for the pulp mill and power plant and also supplied the electrical engineering drawings for the whole mill.

All phases of the project were under the executive direction of William R. Adams, St. Regis vice-president and director, while all design and construction were supervised and coordinated by Justin H. McCarthy, Chief Engineer of the Pulp and Paper Division of the company.

John K. Ferguson, who was in charge of the company's lumber mill at Fargo, Ga., until construction of this mill started near the end of 1950, is resident manager at Jacksonville. John A. McDermott, who was transferred from the company's Tacoma, Wash., mill, is general superintendent. U. J. Westbrook is manager of production for the Southern Division, including pulp and paper manufacturing at both Pensacola and Jacksonville. Albert Ernest is vice-president in charge of southern timberlands and procurement.

The major expansion of the company's kraft pulp, paper, and board capacity at its Pensacola, Fla., "Kraft Center" was completed in April, 1952, with the commencement of production by the No. 4 machine there capable of producing approximately 100,000 tons of kraft paper and board a year and raising the capacity there to 265,000 tons per annum of kraft paper and board.

Crossett Chemical

Crossett Chemical Co., a division of Crossett Lumber Co., Crossett, Ark., began operating this month a new plant for the production of high-grade whole tall oil, according to an announcement by E. M. Godat, Manager.

The new installation, last word in modern engineering design for processing sulphate wood pulp skimmings, is producing whole tall oil at the rate of 6000 tons a year. Designed by Arthur Pollak, New York consultant and outstanding authority on the technology and uses of tall oil and other pulpwood derivatives, it has a potential production capacity four times the present rate. Future plans call for the manufacture of refined, as well as whole tall oil.

Mr. Pollak, who did the detailed drawings in addition to designing the plant, also specified the equipment. Rust Engineering Co. was the builder. Ample storage capacity, close processing control, and ideal transportation facilities are outstanding features of the new plant.

Crossett's tall oil plant adds a fourth product to a growing list from this Arkansas manufacturer. Other Crossett products are methanol, acetic acid, and charcoal.

The tall oil plant is another in a series of expansions for the Crossett paper and lumber empire. The Crossett paper mills, for instance, recently completed an especially thorough expansion and modernization program in the same locality. The first Crossett lumber mill was begun in 1898, marking the beginning of one of the South's leading kraft paper and pulp plants. As one of the first self-perpetuating timber operations in the South, Crossett is now known for its broad utilization of both softwood and hardwood, in increasing quantities, for the manufacture of pulp, paper, chemicals, lumber, and other wood products.

Tall Oil

"Increasing experience in the use of tall oil in such important consumer industries as the linoleum, lubricant, paint and varnish, soap and others, together with an ever widening range of application in other fields, indicates a continuance of the sharp upward trend in production and sales of the 1941 to '51 period over the next 10 years at least."

This statement was made by A. E. Griffin, sales manager of the Chemical Div., Camp Manufacturing Co., in his address at the Naval Stores Breakfast, during the annual convention of the Paint, Varnish & Lacquer Association in Chicago.

Mr. Griffin spoke as a representative of the 40-year-old Southern Pulp & Paper Industry—producer of sulphate pulp for kraft paper—fast-growing customer, neighbor, and competitor of the Naval Stores Industry in the South. "Over the past 30 years the Southern Pulp & Paper Industry has approximately tripled its output every 10 years .... It produces 54% of the domestic wood pulp and about 35% of our nation's production of paper and board."

Production of tall oil, an important by-product of sulphate pulping, has expanded from only 27,000 tons in 1941 to 199,000 tons in 1951. Sulphate turpentine recovery rose in that period from 65,000 to 203,000 barrels.

After a rapid survey of the Southern Pulp & Paper Industry's background, growth, present assets, and future potential, Mr. Griffin summarized by saying, "With intelligent utilization of wood resources, and insistence by the consuming industries not only for sound and ample protective practices but also consistent cutting and replanting programs, the future of the pine consuming industries would seem to be assured."

Crossett Lumber

Three of the world's fastest electric log carriage drives, capable of cutting enough lumber each day to construct as many as 25 small homes, are being built by the General Electric Co. for the Crossett Lumber Co., Crossett, Ark.

Producing from 200,000 to 250,000 board feet of lumber daily, the three amplidyne-control electric log carriage drives each will carry a 12-ton carriage at a speed of 0–50 f.p.m. with a maximum cutting rate of 15 round trips per minute.

The new electric drives are expected to reduce operation power costs by 90% over the previously used steam shotgun drives, according to G.E. engineers. Wood wastes formerly used in making steam, will become available for manufacture into salable products.

G.E. engineers were faced with a special application problem at the Crossett installation. Rapid acceleration and deceleration of the log carriage cause power fluctuations of about 800 kw. for each drive to be reflected in the power system. This situation would go unnoticed in most industrial plants, but Crossett also operates a paper mill from the same power system and thus cannot tolerate any rapid frequency changes.

To solve the problem, the engineers have designed a flywheel, 50 in. in diameter and 12 in. thick, for each motor-generator set to limit the power peak to approximately 200 kw. for each drive. In addition, to further lessen power fluctuations, a 200-hp. wound-rotor motor will be used in place of the 400-hp. squirrel-cage drive motor normally used for this type installation.

General Electric also will supply end-of-track limit switches, amplidyne control panels, and a master controller for the Crossett installation. The drives are expected to go into operation in early 1953.

General Container

The General Container Corp. has issued an interesting booklet memorializing its twenty-fifth anniversary.

Forest Protection

Forest Protection, Ltd., organized by several pulp and paper companies, the Province of New Brunswick, and the Canadian government, has awarded a contract to Central Aircraft, Inc., Yakima, Wash., to spray more than a million acres of balsam fir with DDT to help fight the spruce budworm. The project will require six airfields, already chopped out of the bush, over a million gallons of insecticide, several hundred gallons of gas and oil, storage tanks and piping systems, and 75 airplanes. Equipment and supplies are now being trucked and sledged into the area. It is the largest aerial spraying project in history.

Great Northern

The Great Northern Paper Co. has announced the signing

It's a long cry from CHIPS to COATED BOARD

Whether you have only one board machine in your mill or a whole battery of machines—whether you manufacture one type of board or a complete line from chip to patent coated—the quality of your product and your daily production are dependent very largely upon the selection of your felts.

By availing yourself of the help of the Hamilton sales engineer, substantial economies can confidently be anticipated. His experience is not limited to small mills or to large operations. He is familiar with every conceivable combination of water and solids known to board mills. He is less concerned to sell felts than to help you produce board that you can sell as a satisfactory product.

Please remember this when you see him.

Hamilton Felts

MIAMI WOOLEN MILLS

Established 1858

HULER & BENNINGHOFEN, HAMILTON, OHIO

of a contract with the Beloit Iron Works for the first of two newsprint machines for its East Millinocket, Me., mill. These machines will be designed for a speed of 2000 f.p.m. One machine will produce 325 tons of newsprint daily which is equivalent to the tonnage produced by the four machines in present use. The machine will have some new features such as new designed pressure headbox, suction press equipment, calender stack, and a mechanical differential gear drive.

Whiting Corp.

Whiting Corp., Harvey, Ill., has issued a new brochure describing the Trackmobile which is used for moving freight cars in mill yards.

Kidder Press

The Kidder Press Co., Dover, N. H., has appointed Gibbs-Brower Co., Inc., New York 16, N. Y., as its representative for Kidder slitters and winders in the paper mill field. Gibbs-Brower represented Kidder from 1898 to 1933.

Westinghouse

Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa., has issued a 31-page application bulletin on Control Centers (B-562). Addresses of 15 Westinghouse manufacturing and repair plants that manufacture and service control centers are listed. Analyses are made at these locations by competent engineers, at field level, of the control requirements of the particular machine or application.

Other current Westinghouse booklets include Single-Motor Drives for Paper Machines (B-2279B); Sectional Motor Drives for Paper Machines (B-3045A); Wet-End Auxiliary Motor Drives for Paper Machines (B-3275); Drives for Paper Finishing and Converting Machinery (B-4038); and Steam Turbine Drives for Paper Machines (B-4689).

Allis-Chalmers

Arnold I. Thorsen, Works Manager of Allis-Chalmers Mfg. Co. Norwood Works, has been appointed Assistant Director of Manufacturing of the company's General Machinery Div. at Milwaukee, Wis.

Allis-Chalmers Mfg. Co., 828 S. 70th Street, Milwaukee, Wis., has issued a new bulletin (52B6083A) on "Close-Coupled Pumps."

Du Pont

Du Pont's new chemical weed killer CMU has been reported effective in removing growing grass around pulpwood piles, thereby reducing the fire hazard. The illustration

shows shriveled dead grass in the light strip along the face of a pulpwood pile killed by one application of CMU early last summer. By midsummer the strip was practically bare ground.

General Electric

Several General Electric Co. general managers have been elected Vice-Presidents of the company. Those elected include: James H. Crawford, Motor and Generator Div., Schenectady, N. Y.; Francis E. Fairman, Transformer and Allied Products Div., Pittsfield, Mass.; and Glenn B. Warren, Turbine Div., Schenectady, N. Y.

Hercules

Peter Van Wyck has been appointed Director of the Hercules Powder Co. Experimental Station at Wilmington, Del.

The Virginia Cellulose Dept. of Hercules has added a new high-pressure boiler to its steam-generating facilities at Hopewell, Va., and completed the changeover of half of its pulp production capacity from a combination of batch and continuous processing to all continuous. The installation of another continuous digester should be completed early in 1953. The department announced a new type of chemical cotton pulp having unusually high filtration characteristics for cellulose acetate manufacture.

Fischer & Porter

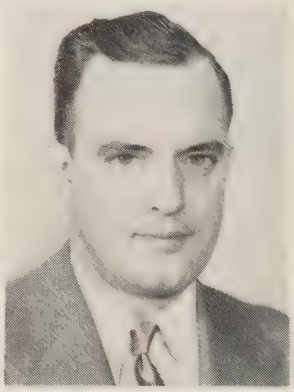
Fischer & Porter Co., 749 Jacksonville Road, Hatboro, Pa., has issued a new catalog (29) on "Instrument Air Pressure Regulators and Constant Pressure Differential Regulators."

Penn Industrial

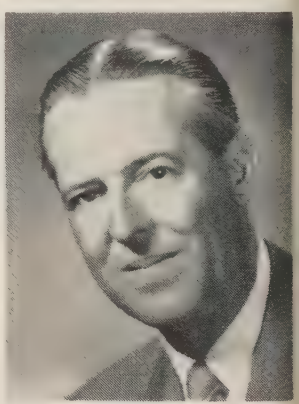
Pennsylvania Industrial Chemical Corp., Clairton, Pa., has announced Piccopali, a new, low-cost, synthetic resin for use by paper mills. A brochure on the subject is available.

Cities Service

Victor A. Denslow has been appointed Manager of Wax Sales for Cities Service Oil Co. with headquarters in the Civic Opera Building, 20 N. Wacker Drive, Chicago, Ill. Mr. Denslow was a chemical engineer with Atlantic Refining Co. before joining Cities Service in 1949 as Supervisor of the Wax Section, Technical Service Laboratory, in East Chicago, Ind.



V. A. Denslow, Cities Service Oil Co.



D. P. Blount, Magnus Chemical Co.

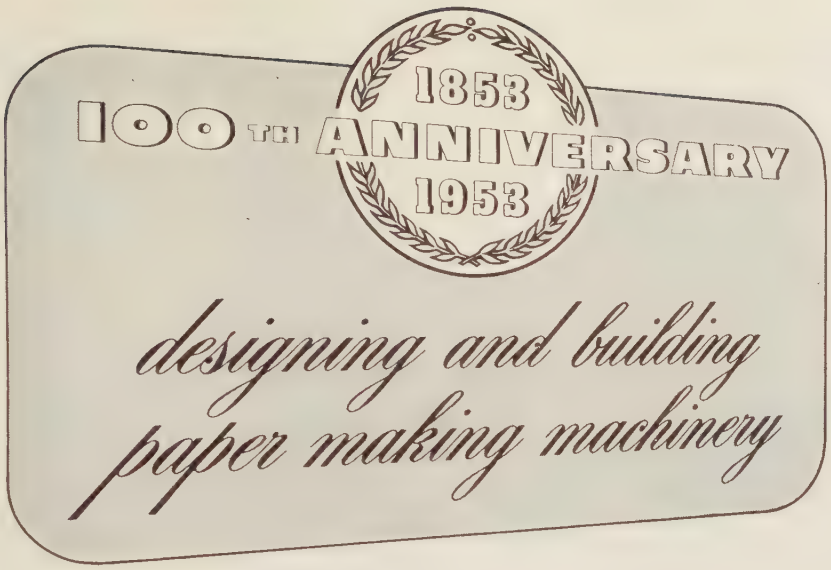
Magnus Chemical

W. Montgomery Campbell was re-elected for the 31st time as President and Chairman of the Board of Magnus Chemical Co., Garwood, N. J. Elected also were Robert W. Mitchell, David Blanchard, and William Garbe, Vice-Presidents.

David P. Blount was elected Vice-President for Chemical Sales.

Torsion Balance

Christain Becker, Division of Torsion Balance Co., Clifton, N. J., has issued a 32-page booklet containing information on the care and use of analytical balances.



Actually, our company was founded in the spring of 1823 by George Goulding. Being a mechanical genius, he was called upon to build and install all kinds of machinery for the many industries that were rapidly springing up in this country.

The increasing demand of building machinery for the papermaking industry that was rapidly establishing itself in Northern New York, and when more capital and more executive ability was needed, George Goulding formed a partnership of Goulding, Bagley & Sewall in 1853. The new co-partnership prospered and continued to expand.

The continuous production of machinery for the papermaking industry resulted in becoming the principle product of the company. A tribute to the initiative of the company and its employees, was the many new developments in machinery that marked the March of Progress of the papermaking industry. The company built the first Voelter grinder made in the United States—the first spring wet machine to handle the pulp from these grinders —and later, a machine capable of producing paper continuously at 1000 lineal feet per minute.

We are justly proud of having been a leader in the March of Progress in the development of the paper industry. So it is in this year of 1953, we celebrate 100 years of service to the paper industry and look forward to the beginning of a second century of continued progressive service.

BAGLEY & SEWALL

WATERTOWN • NEW YORK

Foreign Representative **• CASTLE AND OVERTON, Inc., 630 Fifth Avenue, New York 20, N.Y.**

JOHNS-MANVILLE

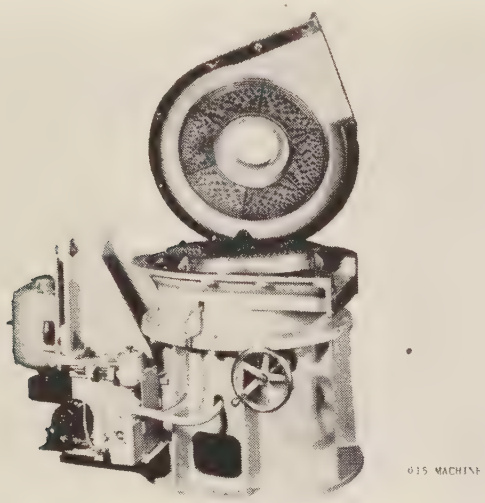
G. R. R. Wahl has been appointed Assistant Product Manager for Transite Pipe by Johns-Manville Corp., 22 E. 40th Street, New York 16, N. Y.

LOCKPORT FELT

Frederic W. Drake died at his home in Pittsburgh on December 12 at the age of 79. Mr. Drake represented the Lockport Felt Co. in the southern states for a number of years, retiring in 1947.

JACKSON & CHURCH

A new bleach mixer capable of attaining higher brightness in paper pulp bleaching through more uniform distribution and bleaching of chemical with fibers is now being manufactured by Jackson & Church Co., Saginaw, Mich. The



The new Jackson & Church bleach mixer

principal application of the equipment at present is with peroxide bleaching of pulp, although it is considered equally suitable for adding other bleaching agents such as chlorine, hypochlorite, or caustic soda. The mixer was developed as an answer to the need of a machine which could handle pulp after it had been compressed to high density by the Zenith Press.

AMERICAN POLYMER

Cole & De Graf, San Francisco, Calif., has been appointed sales representative of the American Polymer Co., Peabody, Mass.

JOHN WALDRON

John Waldron Corp., New Brunswick, N. J., has issued a leaflet describing a new development in shaft couplings.

INGERSOLL-RAND

"Vacuum—The Magic Hat of Industry" is the title of a 12-page magazine. Reprints available from Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y. (Request Form 164.) It describes the many varied uses of vacuum in industry.

MONSANTO

An initial shipment of acrynitrite, an important raw material for the new acrylic fibers was made recently from the Texas City, Tex., plant of Monsanto Chemical Co. Copolymers are used in the manufacture of a variety of resins and emulsions for use in the paper industry.

Roy T. Cowing has been appointed Charlotte, N. C., branch manager of the Merrimac Div. of Monsanto.

A bulletin describing Lustrex X-820, a carboxyl-containing polyelectrolyte resin, has been issued by the Plastics Div. of Monsanto at Springfield, Mass. Lustrex is used in wet-strength papers.

The Monsanto Chemical Co., St. Louis 4, Mo., has issued a booklet on Milmer 1, dealing with protection against rot and mildew.

PENNSALT

The Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia 7, Pa., has appointed E. M. Ott, Manager of its Sales Research Dept. Henry S. Rondeau and the Cleveland Industries Co., 1935 Euclid Ave., Cleveland, Ohio, have been appointed representatives for Pennsalts' corrosion engineering products in Ohio and Northern Kentucky.

GENERAL ANILINE

General Aniline & Film Corp., 435 Hudson St., New York, N. Y., has issued a new 12-page bulletin on polyvinylmethylether. The product is used in adhesives, surface coatings, and heat-sensitized latices.

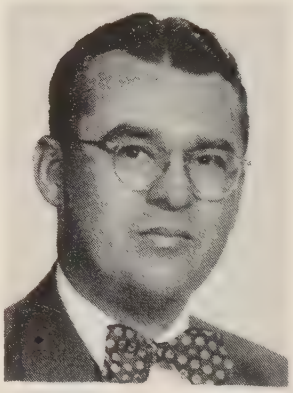
WITCO

A technical service report (s-7) covering the uses and properties of Witco Chemical Co., 260 Madison Avenue, New York 16, N. Y. The product, a polyvinyl chloride resin, is used in packaging papers for foods.

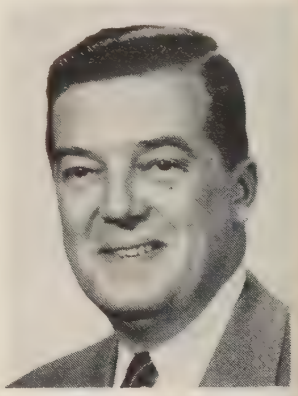
Witco has issued a 32-page bulletin on "Stearates." The product is used to waterproof paper and board.

LOUIS ALLIS

Louis Allis, Jr., has been elected Vice-President. He is succeeded as Vice-President in Charge of Sales by C. G. Skidmore, formerly Sales Manager of the company. Mr. Skid-



Louis Allis, Jr., The Louis Allis Co.



C. G. Skidmore, The Louis Allis Co.

more was recently appointed Chairman of the Integral Motor Div. of the Motor and Generator Section of the National Electrical Manufacturers Association.

STEBBINS

V. B. Bodenheimer has been assigned to the Southern States as Sales and Service Engineer by the Stebbins Engineering & Mfg. Co., Watertown, N. Y., designers, manufacturers, and installers of corrosion-resistant tanks and linings. Prior to joining Stebbins, Bodenheimer was Engineer for the Riegel Carolina Corp. at Acme, N. C., and bleach-plant and mill testing foreman at Champion Paper & Fibre Co., Canton, N. C. He now lives at 2007 N. 11th Avenue, Pensacola, Fla.

UNION

The Trade Name for Top Quality

SCREEN PLATES

MEET THE EXACTING DEMANDS OF CANADIAN PULP AND PAPER MILLS

The quality and dependability of UNION Screen Plates are backed by over forty years' experience in satisfying the needs of Canadian pulp and paper mills.

GIVE MAXIMUM PERFORMANCE UNDER ALL CONDITIONS

UNION Screen Plates are made in our own foundry to our own special formula, using the best materials available. Our laboratory-trained experts control all operations, thus ensuring the utmost satisfaction and value in service.

ALL STYLES AND TYPES AVAILABLE

UNION can supply Screen Plates in any style of cut or number of slots per inch; Chromium Plated, Stainless Steel, Cast Bronze, Phosphor Bronze, Inconel and Rolled Copper. Special Plates also made to order.

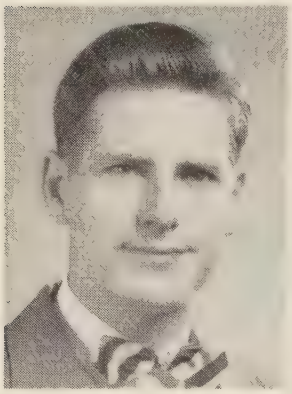
UNION also manufactures a complete line of Screen Plate accessories.

UNION SCREEN PLATE COMPANY OF CANADA LIMITED

Head Office and Plant: Lennoxville, Que. Sales Offices: Montreal and Toronto.

NOPCO

Walter B. Morehouse has been appointed Assistant Vice-President of The Nopco Chemical Co., Harrison, N. J. Mr. Morehouse joined the company in 1940.



V. B. Bodenheimer, Stebbins Engineering & Mfg. Co.

W. B. Morehouse, The Nopco Chemical Co.

PERMUTIT

The Permutit Co., 330 W. 42nd Street, New York 36, N. Y., has issued a new booklet (3803) "Demineralization, Including Silica Removal by Ion Exchange."

HYGROTESTER

The German firm, Paul Lippke, is organizing an American company to handle the sales of the Hygrotester. This equipment, developed abroad, has been designed to regulate the moisture content of the sheet on the paper machine.

OBITUARY

Clarence J. West (1886–1953)

Dr. Clarence J. West, Editor of The Institute of Paper Chemistry and internationally known bibliographer, died January 29, at Appleton, Wisconsin, after a brief illness.

Dr. West, who was born at Brighton, Mich. in 1886, received his A.B. and Ph.D. degrees at the University of Michigan. Earlier he received a teaching degree from Michigan State Normal College at Ypsilanti and was given an honorary Master of Education degree by the latter institution in 1938.

After earning his doctorate in 1912 in physiological organic chemistry, he joined the staff of the Rockefeller Institute for Medical Research. During World War I he served as a major in the Chemical Warfare Branch; subsequently he was promoted to the rank of Lt. Colonel in the Army Reserves. For two years following the war he was with Arthur D. Little, Inc. In 1921 he became associated with the National Research Council in Washington, D. C. He remained there until 1936 at which time he came to The Institute of Paper Chemistry.

He collaborated after the war with General Amos A. Fries, Commanding General of the Chemical Warfare Branch, in writing the first book on the subject of chemical warfare. Later Dr. West also collaborated with Dr. G. J. Esselen in the translation of Dr. Emil Heuser's "Cellulose Chemistry," one of the first standard German Texts made available in English. While with the National Research Council he was editor of the International Critical Tables and the Annual Survey of American Chemistry. For many years he was co-editor of the Organic section of *Chemical Abstracts* and since 1922 in charge of the section on Cellulose and Paper.

His outstanding contribution to the technical progress of the pulp and paper industry received recognition in 1937 when he was awarded the Gold Medal of the Technical Association of the Pulp and Paper Industry. From 1920 until his death, Dr. West had been Chairman of the TAPPI Committee on Abstracts and Bibliography, and had served as Chairman of the Editorial Board of the Association's monthly publication, *Tappi*. His bibliographies in bound volumes cover the period from 1900 to date. He had published more than 700 books, articles, translations, and book reviews. Recently it was estimated that he had prepared more than 30,000 abstracts during his abstracting career—more than any other abstractor has compiled. Because of his efforts the scientific literature of the pulp and paper industry is probably better identified and organized than that of any other major industry.

As Editor and Research Associate in Technical Bibliography at the Institute, Dr. West was responsible for the editing of all technical and scientific publications and the preparation of all bibliographies. In addition, he was a member of the Policy Committee on all scientific articles emanating from the institution. His prominence in the editorial field had led scientists and technologists in many other fields and from all parts of the world to seek his counsel. In addition to holding memberships in the Technical Association of the Pulp and Paper Industry and the American Chemical Society, he was a Senior Member of the Technical Section of the Canadian Pulp and Paper Association and a member of Sigma Xi.

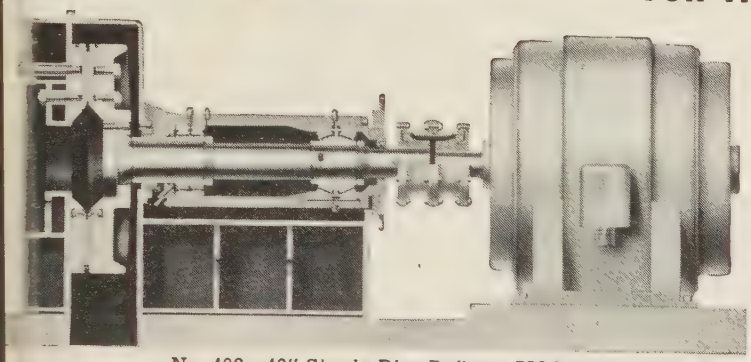
C. J. West

Though he devoted himself to his profession, he found time for other activities. He was intensely interested in Masonry, belonged to many Masonic organizations, and became a 32nd Degree Mason. He was also a past president of the Appleton Rotary Club and a member of the Riverview Country Club of Appleton.

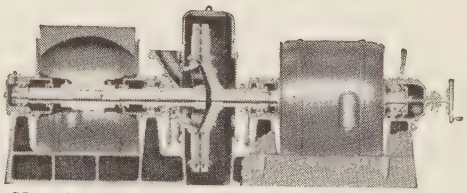
Survivors include the widow, one daughter, Mrs. J. F. Doubleday and one son, Clarence J. West, Jr. A Masonic service was held at Appleton after which the body was sent to Washington, D. C. for interment in Arlington National Cemetery.

THE Bauer LINE OF DISC MACHINES

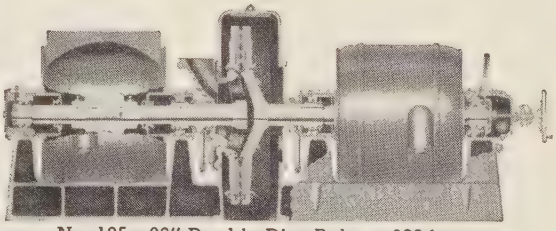
FOR THE PULP AND PAPER INDUSTRY



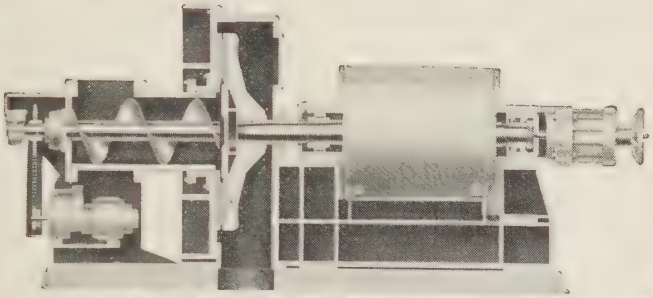
No. 430—48″ Single Disc Refiner; 750 hp.



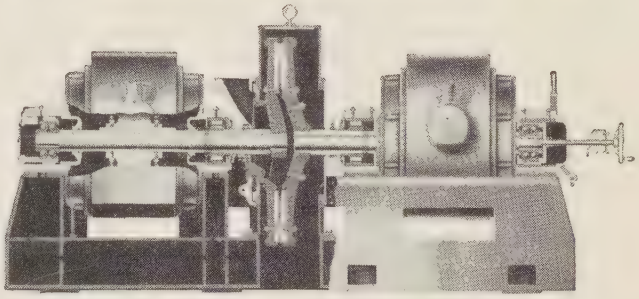
No. 187—24″ Double Disc Pulper; 100 hp.



No. 185—36″ Double Disc Pulper; 300 hp.

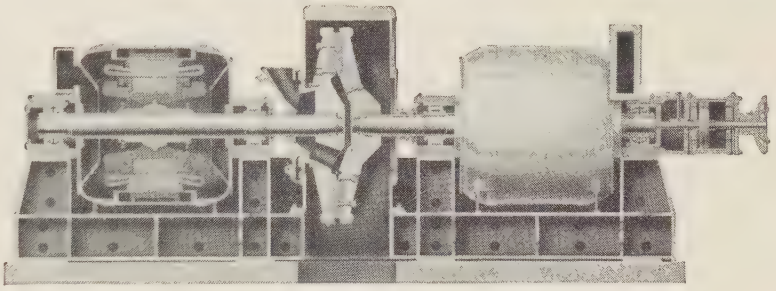


No. 510—40″ Single Disc Refiner; 450 hp.



No. 400—36″ Double Disc Refiner; 400 hp.

No. 245—36″ Single Disc Pulper; 150 hp.



No. 410—40″ Double Disc Refiner; 750 hp.

No. 247—24″ Single Disc Pulper; 50 hp.

No. 248—18″ Single Disc Pulper; 25 hp.

No. 148—8″ Single Disc Mill; 10 hp.

Bauer ALSO BUILDS

- 4 Sizes of Double and Single Disc Attrition Mills
- A Complete Line of Hammer Mills

THE BAUER BROS. CO.

1715 SHERIDAN AVE. • SPRINGFIELD, OHIO

REPORTS AND DISCUSSIONS

Presented at National and Regional Conferences

Chemical Engineering

The following is a report of the Discussion Session of the Chemical Engineering Committee that took place at the Morrison Hotel, Chicago, Ill., on Tuesday afternoon, Oct. 14, 1952.

In opening the Round-Table Discussion, Mr. Lientz inquired as to comments or questions on the use of questionnaires for the securing of information. There was no comment, hence, it was assumed the use of the questionnaire met with no objections and did provide a fairly reasonable method of securing data.

Mr. Burgess of PPRIC outlined briefly the progress of the Canadian Digester Study Group to date. He reported the task force has called on more than half of the Canadian mills. The corrosion problem has been found to be serious from the East Coast to the West Coast. Unlike some U. S. mills, the corrosion appears to be more rapid in lower portions of the digesters. Some coatings have been investigated but no results have been obtained as yet.

With respect to the TAPPI Digester Inspection Data Sheet (*Tappi* 35, No. 7: 136A–137A (July, 1952)) one mill reported its use. Mr. Lientz described the plots of thickness at the thinnest portion as they are used at the Savannah mill of Union Bag & Paper Corp. Mr. Shoumatoff described the use of a chain with markers properly spaced for indicating the points of wall thickness measurement thus assuring one of all measurements being made at the same spot as previously.

Scott Henry inquired as to designs of collapsible inspection platforms. Messrs. Shoumatoff and Lientz described the platforms used in their respective mills. Comments were made on the use of chip platforms and inflated rubber boats floated on water in the digester.

A rather vigorous discussion revolved around the general subject of field repair of digesters. The question was raised as to how much welding can be done before it was necessary to stress relieve the digester. It was indicated that more than 60% of the minimum allowable thickness must remain and that areas up to 8 in. in diameter could be welded.

B. A. Hopper outlined the method of weld overlay repairs. He mentioned he is preparing a paper on this subject for the February TAPPI Meeting.

S. J. Baisch outlined a procedure for ring replacement and commented upon the use of Inconel strip field lining which has suffered some cracking in the welds.

C. W. Smith related briefly his experience in the cracking of three carbon steel shells which had been repair lined in the field with Inconel strips. The cracking was presumed to be caustic embrittlement due to the concentration of liquor behind the lining.

H. O. Teeple commented on the matter of the use of Inconel for alkaline digester linings:

"The advantages of Inconel for alkaline pulping include adequate resistance to over-all corrosive attack plus freedom from stress corrosion cracking by the alkaline liquors even if these should become concentrated in confined spaces. The fact that the thermal expansion of Inconel is close to that of steel is also desirable.

"The benefits from an Inconel lining will be influenced by the attention that is given important details. The most important is to insure that all joints are tight so that liquor cannot penetrate between the lining and the shell. The general procedure for accomplishing this is described in Inco's Technical Bulletin T-2. Special attention must be given inspection to detect leaks immediately after fabrication and periodically during the life of the vessel so that any leaks that may be discovered may be eliminated by appropriate methods; special dye check techniques for disclosing leaks have been developed. These and other matters peculiar to any installation can best be handled by Inco Technical Service Section who will be glad to discuss details with you by correspondence or at firsthand as you may prefer.

"The desirability of preventing accumulation and concentration of cooking liquor behind a lining is based on observations that steel shells subjected to the action of such concentrated alkaline cooking liquors may suffer stress corrosion cracking or caustic embrittlement. This may occur irrespective of the material used for the lining.

"Whether or not such cracking of the shell will occur in any case will be determined by such factors as the level of stress (residual from fabrication plus applied from service), the nature of the steel, the operating temperature and the embrittling characteristics of the concentrated liquor. These factors vary considerably from digester to digester so it is difficult to predict whether stress corrosion cracking will represent a problem in any particular instance. So far only one case of cracking suspected as being due to caustic embrittlement has come to Inco's attention. Nevertheless, in view of the hazards involved, it is prudent to take precautions to avoid such difficulties. These include elimination of leaks and stress relief annealing of shells after lining."

The question of stress relieving of digester welds was discussed and it was stated that while each circumstance should be judged on its own merits, generally adequate stress relief could be obtained by the use of a burner inside the shell and maintain a temperature of 950–1000°F. for a suitable period in the shell as measured by thermocouples embedded at various places over the digester. It was also pointed out that for circumferential welds requiring stress relief to meet code specification, this could be done by induction heating using 60-cycle alternating current. The use of water-cooled copper tubing 18 inches either side of the weld for carrying the current was mentioned as meeting code specifications for weld stress relief.

There was a considerable amount of discussion on the subject of what people would buy for digesters in the light of current experience and knowledge. The general consensus was that in view of price differentials between carbon steel and alloy digesters, most people would prefer the carbon steel and replace them when necessary.

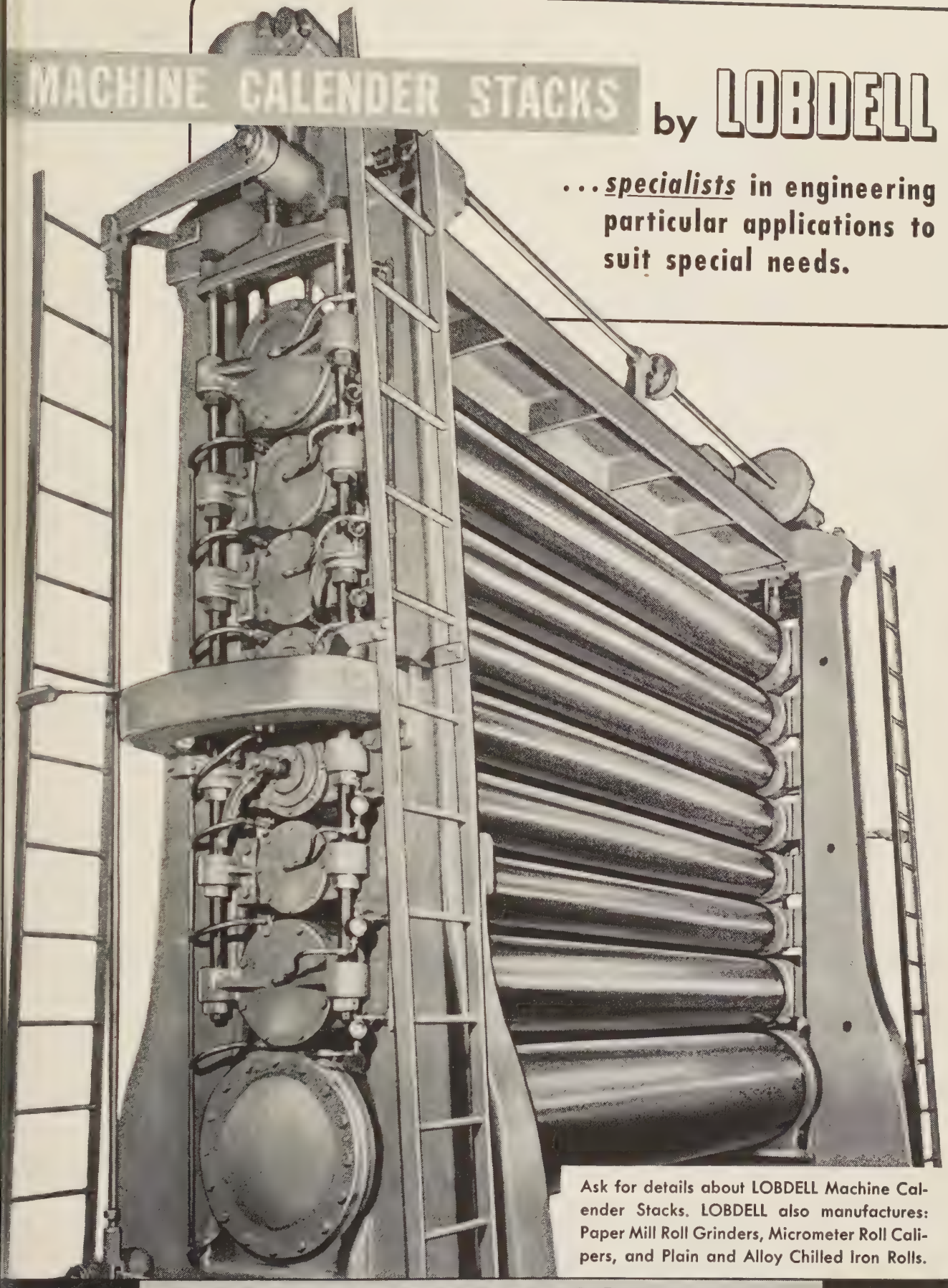
One mill which has five Inconel digesters in service indicated it would seriously consider Inconel for further purchases. It was reported at this mill that the A-212 steel digesters were not standing up as well as were some A-285, based upon information accumulated to date on these two steels.

Another mill reported a rimmed steel digester was corroding at about one half the rate of an A-285 but the corrosion pattern was the same. In this case, the comment was based upon current information.

A question arose as to the possible use of Hastelloy Alloy F and Mr. Henry of A. O. Smith remarked that his company's experience was primarily confined to sulphite pulping but some data were available on kraft pulping which were to be re-

MACHINE CALENDER STACKS by LOBDELL

...*specialists* in engineering particular applications to suit special needs.



Ask for details about LOBDELL Machine Calender Stacks. LOBDELL also manufactures: Paper Mill Roll Grinders, Micrometer Roll Calipers, and Plain and Alloy Chilled Iron Rolls.

1836

LOBDELL UNITED COMPANY

WILMINGTON 99, DELAWARE

A SUBSIDIARY OF UNITED ENGINEERING AND FOUNDRY COMPANY

1953

leased in a TAPPI paper scheduled for presentation at the February meeting.

With respect to the use of carbon brick linings, B. Thomas mentioned he was preparing a paper on this subject for the October meeting. However, he presented a brief résumé, as follows:

"There are now approximately 70 carbon linings in service in kraft digesters. The oldest lining has been in service for 16 years with little maintenance during that period. There are several linings between six and eight years old which, for the most part, have given trouble-free service. Following the development of carbon having improved properties, very many installations have been made more recently using a lesser lining thickness. Some of these have been very successful while others have been very troublesome. Most of the causes of the troubles have been isolated and, based on the experience on installations to date, it is believed that dependable linings can be installed in the future provided that proper control or knowledge is obtained of such variables as shell thickness and condition, lining thickness, carbon brick quality, etc."

After some additional general discussion the meeting was adjourned at 5:30 p.m.

H. O. Teeple, *Secretary*
Chemical Engineering Committee

LETTERS TO THE EDITOR

Corrugated Board Containers

To the Editor, *Tappi:*

We have been very much interested in Mr. Gershill's letter telling of the desire of South African packers to build better boxes. This appeared along with three responses in the November issue of *Tappi*, pages 133A–136A.

We believe it is not proper to leave him with the impression that silicate adhesives are not preferred for combining corrugated board in the United States. Many boxmakers do use starch because it is easy for untrained men to handle, but it is also true that many former starch users are turning back to silicate because they recognize the need for such an adhesive if they want to obtain a quality box which their trade demands. The ability of silicate-clay adhesive mixtures applied with ordinary techniques gives a stronger box more economically than can be obtained from starch adhesive and is now generally recognized.

There has been a definite trend back to silicate adhesive in the United States paralleling the return to more competitive conditions with performance testing against specifications again used in buying.

This brief statement of our conviction represents another facet in this controversial subject. We know that you will wish to properly pass it on to Mr. Gershill and other interested readers.

R. L. Kreyling, *Manager*
Adhesives Sales Service
Philadelphia Quartz Co.

Ammonia-Base Sulphite Cooking

The following questions and responses relate to a European inquiry concerning the pulping of resinous woods by the ammonium bisulphite process. The identities of the inquirer and the respondent are not shown. The information given is of value and is presented for this reason.

Q.: Is it possible to cook industrially with ammonia-base acid resinous woods like the various kinds of pine heartwood or woods containing inhibiting compounds for the calcium-base liquor?

A.: It is possible to make sulphite pulp from Douglas-fir by this process. However, the difficulties are only lessened in degree, not eliminated. It is still much more difficult to pulp Douglas-fir satisfactorily than to pulp western hemlock. We do not have any experience with cooking of jack pine by this process. Of course the pitch content of these woods becomes a source of trouble.

Q.: What screening rate do you obtain?

A.: At the same hardness, ammonia-base western hemlock pulp screens in about 60% of the time required for calcium base pulp. Douglas-fir ammonia-base sulphite pulp is about 50% harder to screen than western hemlock calcium-base pulp.

Q.: Is the pulp obtained by this process suitable for the same usages (wrapping paper, fine writing paper, semiglassine) as calcium-base pulp?

A.: For wrapping papers the ammonia-base pulp is better, except for low brightness. Strengths and sizing are superior to those of calcium-base pulp. We have no information on its use on fine papers and glassine-type sheets.

Q.: Is it easily bleachable?

A.: Yes, and this is one of its main advantages. Although it bleaches in almost the identical manner to calcium-base pulp of the same hardness, the raw pulp can be cooked to a lower chlorine number without loss of strength. Thus an ammonia-base pulp of chlorine number of 5 will have the same strength as calcium-base pulp of chlorine number of 7 or 8, while chemical savings can be made in bleaching.

Q.: Did you find any serious and immediate dangers in the use of regular digester linings?

A.: Our regular lining consists of two brick courses set in litharge-glycerin cement. We left one of the digesters at one of our mills with this type of lining and replaced the other lining with denser bricks (Stebbin) set in resin cement, with total thickness of 7 in. We were surprised to find that the regular lining stood up quite well. However, we will make all new linings with the denser brick and resin cement.

Universities and Industry

To the Editor, *Tappi:*

The editorial page of the December issue of *Pulp & Paper* carried a very interesting note dealing with "glamorizing" the appeal of the industry to the colleges. The editor said in part: "Pulp and paper industry executives are doing the industry a service when they seize every opportunity to meet young college graduates.... In November, in Seattle, the executives were given this chance at a meeting on the University of Washington campus. It might be duplicated at other schools."

It may be interesting for me to outline what happened before the meeting in Seattle and what's been happening since. The meeting at the University of Washington was the second one in quite a series which we at the Institute have been organizing to tell the story of the pulp and paper industry to college and university students, using in most cases Institute alumni as speakers or panel members, the first being held at Pennsylvania State College in October. It had been quite apparent to us for some time that extra efforts would have to be made to attract young college graduates (particularly technical graduates) into the industry this year and next. These extra efforts seemed necessary in view of the shortage of technical graduates during these two years and also because of expanding needs for technical men by industry and government.

One approach to the problem we felt should be for us to arrange with organized student groups of the types of the Student Affiliates of the American Chemical Society and the student chapters of the American Institute of Chemical Engineers on various campuses for progress dealing with the

DICALITE'S DIATOM DEPOSITS...

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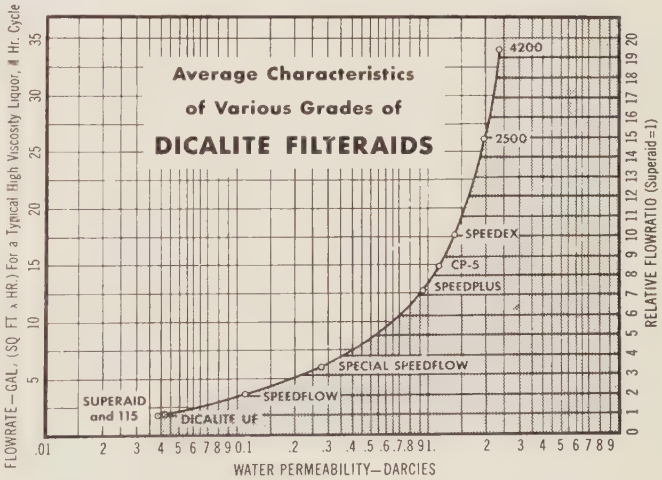

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pulp and paper industry and its many opportunities. Naturally we had in mind interesting some of these students in the graduate program of The Institute of Paper Chemistry. Our preliminary letters were directed to the heads of chemistry or chemical engineering departments in most cases, and these individuals, in turn turned them over to the responsible students or the responsible related faculty man. The response has been fine, we think.

Arrangements were made at Pennsylvania State College for the first meeting, to be held on October 17. The audience consisted of the seniors in chemical engineering and other interested students. A panel meeting was arranged which set the pattern for the later meetings; making up the panel were two of our graduates—John Tongren of the Hammermill Paper Co., Erie, Pa., and John Leech of the West Virginia Pulp and Paper Co., Luke, Md., with me as moderator. The second meeting was the one already referred to—held at the University of Washington on November 6. Here the panel consisted of a number of our graduates together with A. F. Armstrong, the West Coast Personnel Manager for Scott, Russell LeRoux, Manager of the Everett Mill of Weyerhaeuser, and Don Pierson of the Puget Sound Pulp and Paper Co. The Institute alumni who joined with me for the meeting included P. C. Baldwin, Assistant Vice-President of the Soundview Division of Scott, C. W. Cassell, Chief Engineer of the Everett Pulp and Paper Co., J. M. McEwen, Technical Director of the Everett Pulp and Paper Co., and F. C. Keeney, a Project Chemist at the Everett Mill. Arrangements were made through Professor McCarthy of the Chemical Engineering Department at the University and his help was greatly appreciated. The following night a larger panel was brought together at Reed College at Portland. Here Reed seniors and juniors and a few sophomores interested in chemistry formed the audience together with the President of the college, the five members of the Chemistry Department, and one of the members of the Board of Trustees. The panel included T. R. Probst, Assistant General Manager of the Oregon Pulp and Paper Co., R. C. Crain, General Superintendent of the Columbia River Paper Mills, S. J. Robinson, Vice-President and General manager of the Publisher's Paper Co., R. E. Baker, Mill Manager, and H. W. Bialkowsky, Director of Research of the Longview Mill of Weyerhaeuser, J. C. Brown, Technical Director of the Springfield Mill of Weyerhaeuser, J. D. Wethern, Chief of the Experimental Pulping Group of Crown Zellerbach Corp., and myself. On November 10 I talked to the senior chemical engineers at the University of Colorado at Boulder about our industry. Unfortunately, a panel could not be set up because of the distance of Boulder to the mills in this case.

The December meetings were started at Northwestern University on December 1. This again was a panel meeting, the alumni on the panel including J. C. Woolwage, Technical Research Chief of the Kimberly-Clark Corp., E. J. Jones, in Charge of Research and Product Development Department of The Celotex Corp., H. J. Allison, in the Research Department of the Container Corp., and R. J. Van Nostrand of the Chicago sales office of the Brown Co. The moderator of this panel was John G. Strange, the Vice-President of the Institute. How well this panel discussion was received is indicated by the fact that the question and answer period ran on for about an hour and a half after the formal meeting was over. The December series of meetings also included talks on the industry by our alumnus, D. M. Martin, Chief Chemist of Cornell Paperboard Products, Milwaukee, and one by me; the first was presented before the A.C.S. Affiliates of Marquette University on December 2, the second before the A.C.S. Affiliates of the University of Indiana at Bloomington on December 5.

With the opening of school after the Christmas vacation, our activities stepped up. On January 12 there were three meetings held in St. Louis, Philadelphia, and Kingston, R. I. E. J. Loutzenheiser, Superintendent of Atlas-Boxmakers, Inc., addressed the St. Louis meeting; the audience consisted of the A.C.S. Affiliate and student chapter of the A.I.Ch.E at Washington University. The second meeting that evening was held in Philadelphia, sponsored by the student chemistry group at Temple University. The Temple panel was moderated by Dr. J. E. Todd, Dean of Admissions of the Institute; on the panel were two alumni—A. J. Haug, Paper Mill Superintendent of the Chester Plant of Scott Paper Co., and A. L. M. Bixler, Plant Superintendent of the Warren Mill of the Riegel Paper Corp. The Rhode Island meeting was one of the Career Hour programs held by the student chapter of the A.I.Ch.E. of the University of Rhode Island; the alumnus here was George Knight, the Mill Manager of C. H. Dexter & Sons, Windsor Locks, Conn.

Future meetings already set up include the following: on January 19 Dean E. W. Schoenberger, Dean of Students at the Institute, will be moderator of a panel to be given before the A.C.S. Student Affiliate of the University of North Carolina at Chapel Hill. Members of the panel include W. D. Harrison, Vice-President in Charge of Production of the Riegel Paper Corp., P. R. Wiley, in Charge of the Development Department at the West Virginia Pulp and Paper Co., Charleston, S. C., and A. P. Yundt, in Charge of Research at the Camp Manufacturing Co., Franklin, Va. The same panel will hold forth on the North Carolina State College campus on Tuesday, January 20.

Although the Annual Meeting of TAPPI interferes somewhat with February meetings, the following have been definitely set. On February 4, Kenneth Arnold, Technical Director of the St. Regis Paper Co., and I will appear as a miniature panel before the student groups at Clarkson College of Technology in Potsdam, N. Y. On February 5 a somewhat larger panel consisting of three alumni—Henry Fisher of Scott Paper Co. in Chester, C. R. Calkins of the Riegel Paper Corp. in Milford, and Francis T. Ratliff of Personal Products Corp., Milltown, N. J.—will appear with me before the student groups at Franklin and Marshall College at Lancaster, Pa. On February 10 two of our alumni—P. E. Shick of the Mead Corp. in Chillicothe, and J. J. Higgins of The Ohio Boxboard Co. in Rittman—will be with me at the College of Wooster. On February 12 I will speak to the student group at Bucknell University. On February 13 Dean Schoenberger will have a panel meeting at the University of Cincinnati with three alumni from the Cincinnati region. A small panel will be held at the University of Vermont on February 14.

Meetings have also been scheduled for March and April, but there is no need of extending this letter further by listing them. We hope to set up similar meetings next year. Of all the schools we have contacted, only in three cases did we have complete turndowns, and we have other contacts in two of the three. As you know, in addition to such meetings as these Dr. Todd and I regularly visit a large number of colleges and universities. This year the number will probably be around 60.

The above is, I hope, at least a partial indication that the suggestion made by the editor of *Pulp & Paper*—namely, that the Washington meeting might be duplicated in other schools with profit—has received an answer. There is much yet to be done, and the more meetings of this kind that are held the better; in fact one paper company is going ahead on an independent program of a similar nature. They are now arranging for meetings in four of the outstanding technical schools.

With best regards,

Sincerely,

HARRY F. LEWIS, *Dean*
The Institute of Paper Chemistry,
Appleton, Wis.

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LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Ohio

The Dec. 11, 1952, meeting of Ohio TAPPI was held in the Moose auditorium, Hamilton, Ohio, with an attendance of 176.

The subject of the evening was stream improvement, and a number of manufacturers of stream improvement equipment were available with generous supplies of descriptive information and models of equipment on display.

The speaker of the evening was C. M. Conner of W. C. Hamilton and Co., Miquon, Pa. He described the problems he had encountered in determining what types of wastes could be handled with certain types of equipment used to treat effluent from his company's mill which has seven fourdrinier machines making fine papers.

He had excellent colored photographs to show the construction of his equipment and certain operating conditions which were encountered. The materials which cannot be treated successfully before the water is returned to the river are segregated and dewatered and hauled by truck to lagoons.

His experiences with the Pennsylvania Sanitary Water Board and those living near the plant in Pennsylvania, gave the papermakers of Ohio TAPPI a foretaste of what to expect from such sources if similar regulations are enforced in the area served by Ohio TAPPI.

Following his talk an excellent film entitled "River at Your Door" was shown to show how the water users along the Raritan River plan to solve their stream improvement situation by installing a trunk sewer to collect domestic and industrial wastes from a number of communities, and treat them in one large and efficient plant economically. This film is available to any who wish to use it through W. H. Baumer, Secretary of the Middlesex Sewerage Authority, New Brunswick, N. J.

Meeting of January 8, 1953

One hundred eight members of Ohio TAPPI enjoyed an excellent panel discussion on "Polyethylene Extrusion Equipment and Its Application in the Packaging Industry" at the Manchester Hotel, Middletown, Ohio, on Jan. 8, 1953.

Robert C. Sturken of Frank W. Egan and Co., Bound Brook, N. J., explained the equipment used for the proper application of the coating. The resin is supplied in granular or powder form and drawn from the feed hopper by a rotating screw which compacts and displaces all the air from the plastic. Heat is applied to the plastic by contact with the heated metal walls of the barrel of the extrusion mechanism, steam being used for plastics requiring low temperatures, oil for the intermediate temperatures, and electric heat for the higher temperatures which may be as high as 650 to 700°F. These high temperatures are required for polyethylene of high molecular weight and nylon and individual controls are furnished on several zones of the barrel with those materials.

A filter consisting of a pack of stainless steel screens supported by a perforated metal plate is installed at the discharge end of the extruder to remove foreign particles and create a back pressure for the proper functioning of the screw. Leaving the screen section the resin continues to flow under the pressure created by the screw, through a heated adapter to a point of discharge into the coating machine.

An extrusion-fed reverse roll coater with a preheating roll to warm the paper has been successful in applying coatings of polyethylene with a molecular weight as high as 14,000. Since the ideal grades of polyethylene for coating paper have a molecular weight of 20,000 or higher, this process has been discarded for this resin in favor of the direct extrusion lamination process.

The nylon or S-polymer resins in the direct extrusion process are discharged from the extruder into a horizontal sheeting die which forms the resin into a thin film. The opening slot in the die is commonly set from 0.012 to 0.020 in. and hot extruded film is laminated onto the paper to form a coating in a specially designed film laminator consisting of a water-cooled roll and rubber pressure roll located directly beneath the sheeting die. Paper may be preheated if it has a high moisture content or a high weight per unit area such as board. Laminating pressure varies from 60 p.s.i. on soft materials such as board to 100 p.s.i. for smooth materials such as foil and glassine. Hardness of the rubber roll varies from 60 to 90 durometer depending on the materials to be coated.

The sheeting die and the water-cooled laminating roll are the key features which contribute to the success of the process. The die consists of a horizontal tube which can be fed at the center or one end. The material discharges vertically downward through a slot and is formed into a film of precisely controlled thickness by means of adjustable jaws at the bottom of the slot. The die is electrically heated with temperature controls on individual zones to maintain uniform temperatures throughout its length and its jaws are adjustable by means of closely spaced screws. Uniform film as wide as 120 in. can be produced with a die of this cross section.

The cooling rate of the water-cooled laminating roll is determined by calculating the amount of heat to be removed and passing sufficient cooling water through the roll to limit temperature rise to 5°F. per pass. Water is recirculated to give a high internal velocity and low temperature rise without wasting water and to permit temperature control of the roll.

Speed of the paper is maintained considerably greater than the speed of the film emerging from the die so that coating thickness becomes a function of paper speed and extrusion rate.

The machine should be kept in continuous operation if possible, because the last zones of the extruder and the sheeting die are at about 600°F. and rapid oxidation of materials takes place unless these elements are cooled rapidly when the machine is stopped.

The die is V-shape to get as close to the nip of the laminating rolls as possible to reduce the heat loss of the film to a minimum. Adhesion of film to the paper can readily be lost if it contacts the water-cooled roll or the paper before pressure is applied.

One disadvantage of this process as it is now operated is that the extruded film thickens at the edge when it is stretched. This means that about 1 in. of paper containing $^1/_2$ in. of plastic coating must be trimmed from each edge of the web as it leaves the coater. This coated broke results in considerable waste of plastic and means are being studied at present to coat the plastic wider than the sheet so that the excess material can be recovered and reused. Machines in sizes 42 to 72 in. wide are in widest use, but the largest are 90 to 120 in. wide. Laboratory units 12 to 24 in. are also available. $4^1/_2$ in., 6 in. and 8 in. extruders are now available capable of producing 250 to 1000 lb. of coating material per hour. The electrical power requirements of a machine with a 6 in. extruder are about 100 kw. of electric heat with a 50-hp. and a 15-hp. motor for other drives. A typical 72-in. machine can deposit 500 lb. of material on 1000 lb. of 30 lb. kraft paper at a

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speed of 250 f.p.m. with a 2 or 3-man crew to operate the machine. A standard unroll machine of this size costs about $45,000 but smaller machines are available at $30,000 to $35,000. Larger machines with 8-in. extruders, capable of speeds up to 1000 f.p.m. with flying splice may cost as much as $100,000.

There are now 25 production machines and 5 laboratory machines in operation in the United States, 2 in Canada, and 2 in England and additional machines scheduled for England, the Netherlands, and Italy. Future machines are receiving consideration in France and Germany.

Kenneth A. Arnold, Technical Director of St. Regis Paper Co., Deferiet, N. Y., discussed some of his experiences applying polyethylene coatings to various kinds of paper. Polyethylene is an excellent coating material because of its moisture and water resistance; its flexibility and toughness even at low temperatures; its high yield per pound of material applied; its stability on aging; its resistance to grease and certain chemicals; its freedom from taste and odor and toxic effects; and the fact that it does not fuse with most materials which are packaged. Its main disadvantages are its permeability to oxygen and organic vapors.

Since 1950 the output of coated paper at St. Regis has averaged 20 tons per day or about 1% of their total production.

One of the difficulties experienced is breaking of the hot film which leaves voids in the coated surface. This may be caused by insufficient temperature at the die or at the roll surfaces. Drafts of air around the die also contribute to this difficulty. Moisture in the granules of stored material also causes trouble but this can be eliminated if the plastic is warmed before being placed in the hopper of the extrusion unit.

"Fish eyes" in the molten film can also give trouble. They are caused by fibers or other foreign material. They may also be caused by high molecular weight particles or oxidized or jelled polyethylene. In checking the causes of the trouble tests show that high molecular weight particles will melt while oxidized or jelled particles will not.

Obtaining a uniform film is another problem. This problem has been partially corrected by the recent development of the metering type worm to prevent surging and variable coating weight in the material deposit. Reducing capacity to 80% of rating and circulating hot water inside the worm, it is possible to extrude 500 lb. per hour on the 8-in. extruder with very little variation in coating weight. The material deposit variation depends on the accuracy of adjustment of the jaw blades and usually varies $\pm 5\%$.

Occasionally a difference in extrudability is observed from one batch of resin to another. Melt index appears to be the best routine laboratory control method for evaluating resin. Batches may be selected for correct sequence of extrusion from melt index. Uniform size and shape of granules improves extrusion rate. Smaller pellets make higher rates possible.

Adhesion of film to the paper is affected by temperatures of the hot polyethylene film and the paper to which it is to be applied. Pressure in the nip, paper speed, weight of the film, type of the paper furnish, and finish also have their effect on adhesion.

Polyethylene coated kraft can be run up to 450 f.p.m. on tubes when fabricating bags. For highly corrosive, or high grease bearing contents the inner polyethylene seam may be heat sealed seam to seam up to 400 f.p.m. The softness of polyethylene coated paper makes it ideal for packaging applications. It is subject, however, to friction heating and scratching on the tube runner at high speeds. Many multiwall bags do not require the polyethylene coating on the inner surface. When bag closures are sewn the sewn ends may be wax dipped for complete sealing. Valve bags are equipped with polyethylene coated sleeves for tuck in closure. Multiwall bags with polyethylene coated ply are sufficiently moistureproof for several products without dipping sewn ends.

Today polyethylene sheets are used to construct bags for: dried and powdered milk, peeled potatoes, sodium silicate, cyanamid, sodium aluminate, animal tankage, sweeping compound, moulding compounds, plastics, polyethylene resins, plaster, peat moss, calcium chloride, cornstarch, sugar, soap, detergents, doughnut mix, insecticide, sodium sulphite, fire clay, cellulose acetate, humus, meat trimmings, dextrose, glues and pastes, borax, asphalt filler, oxalic acid, dried sewerage, benzene hexachloride, and sodium bisulphate and many other materials.

In the question period following the two presentations the speakers explained that polyethylene was a polymer of ethylene gas with molecular weights ranging from 8000 to 24,000. The cost per pound of the 24,000 molecular weight is about 5 cents higher than the standard at present. The 20,000 is better for coating purposes than the lower molecular weight materials which tend to be waxlike.

A typical 6-in. extruder has a screw 96 in. long and designs are now being made for a 22-in. diameter extruder to have a capacity of 3000 lb. per hour. The widest machine at present is 126 in. wide and the heat on the die causes a $^3/_4$ in. droop on the ends with relation to the center. Building rectangular dies has partially overcome the droop. Dies are fed both from the ends and at several other points on the wider machines.

When polyethylene is applied as a coating to crepe paper the paper is creped prior to coating. The question of applying the coating to paper in the paper machine was also discussed. It was explained that this would be a wasteful process especially because coated broke is useless and can only be disposed of by burning.

The importance of having a spare die was again emphasized so that if it becomes impossible to keep the coating machine in continuous operation a spare die could be cleaned and honed while the regular die is in use. Cleaning of oxidized or jelled plastic is accomplished by using hot solvent solution and the jaws of the die must be honed by hand after each cleaning to remove scoring.

Water is used on the rubber roll to prevent the polyethylene coating from sticking to it.

The March 10, 1953, meeting of Ohio TAPPI will be at the Manchester Hotel in Middletown with J. Edward Todd of The Institute of Paper Chemistry, Appleton, Wis., speaking on "Selection of Technical Personnel."

The Thursday, April 9, 1953, meeting will consist of a trip to Springfield, Ohio, for a plant visit to Bauer Bros. in the afternoon, dinner at Crowell Collier Publishing Co. with a trip through the plant followed by a talk on Rotogravure printing in the evening.

The annual meeting will be on Thursday, May 14, 1953, at Hartwell Country Club of The Cincinnati Gas & Electric Co., in Cincinnati and will be ladies night with a dinner and a speaker.

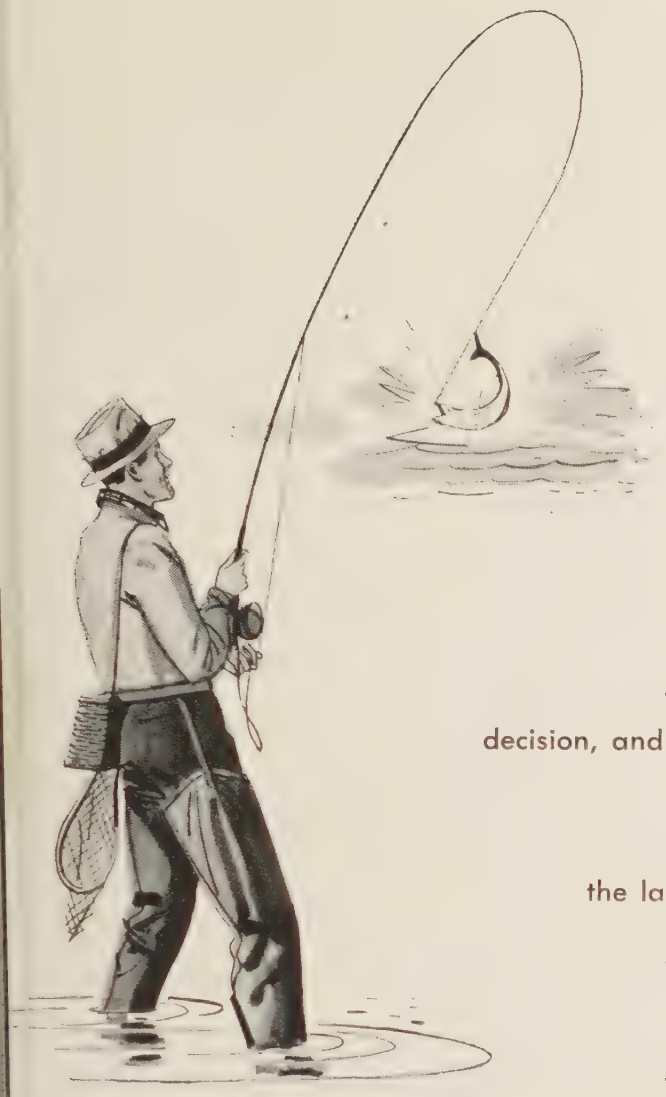
GEORGE B. GREGG, *Corresponding Secretary*

Kalamazoo Valley

The regular monthly meeting of the Kalamazoo Valley Section took place Thursday, Dec. 4, 1952, at the Hotel Harris in Kalamazoo, Mich., at 6:30 p.m. About 150 were present. Thomas Luey, Section Chairman, presided and the speakers were introduced by Richard Trelfa.

The subject was "Control in the Manufacture of Paper and in Printing." O. H. Somers of Western Printing and Lithograph spoke concerning the printer's control problems and Warren Purcell of the Brown Co. on those of the papermaker.

Mr. Somers began by recognizing that there was variability inherent in paper. He stated, however, that variability was of two types, that due to chance and that due to assignable cause. Statistically he was interested in both types, but sought to aid himself and the mills by seeking out and connecting assignable cause. He showed several charts illustrat-



TENAX FISHING AWARDS FOR 1952

The entries are all in, the Judges have made their decision, and the prizes have been sent to the skillful fishermen who were the winners.

Over 200 entries were received and since only the largest were sent in, this is some kind of a record.

The winners were 16 First Prize, 15 Second Prize, 11 Third Prize.

THE NATIONAL GRAND PRIZE, a 10 h.p. Johnson Outboard Motor, was won by Harry W. Bare, Sinking Spring, Pennsylvania, an employee of the Acme Paper Board Division, Federal Paper Board Company, Reading, Pennsylvania. His entry, a 16½ pound Large Mouth Bass.

The all-time world record for this species is 22 pounds, so Mr. Bare is to be congratulated for his outstanding feat.

Every person who entered a fish in this contest will receive a Tenax Fishing Contest Award pin to show he is a member of this exclusive group. In the near future Lockport Felt will issue a brochure of this year's contest in detail. All of the winners and their catches will be listed. Also details of the 1953 Tenax Fishing Contest.

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ing the benefits of this type of control, ream count, ink consumption, and moisture as related to curl.

Mr. Purcell seconded Mr. Somers' idea of variability in paper all the way from the wood to the dry end. He talked of the value of statistics in classifying these variables, but felt that concepts of ideas came before control techniques. One must start with full facts and definitions of tolerances. He gave as an example the trade custom tolerance of $\pm 5\%$ in basis weight. Some suppliers had told him that an average of an entire shipment could vary this much, others that any given sample could, but the average must be close to specified weight.

He also stated that the correct approach to statistical procedures was to let the facts form one's opinion, not vice versa.

J. A. DEAN, *Secretary*

Delaware Valley

The Delaware Valley Section met at the Engineers Club, Philadelphia, Pa., on Dec. 12, 1952. Seventy-seven members and guests attended the supper and evening program. Harold Brill of Du Pont, chairman of the Delaware Valley Section, opened the meeting by reminding the group that Jack Harper of Dowingtown Manufacturing Co., publicity chairman of the Section, requested everyone's help in supplying him with items for the monthly news letter. Mr. Brill also urged that the members assist W. P. Dohne of Dixie Cup Co. in the collection of routine control methods and material for TAPPI Data Sheets. Such material should be forwarded to Mr. Dohne as soon as possible, so that he can submit it to the National TAPPI Committee before the February convention.

Mr. Brill then called upon Frank Lovegren. Program Chairman, to introduce the speaker of the evening. Mr. Lovegren presented H. H. Hanson, president of W. C. Hamilton and Sons, who spoke on the subject "Problems of Managing a Paper Mill." A summary of Mr. Hanson's comments follows.

It is a real pleasure to be here at the Delaware Valley Section of TAPPI this evening and to see many of my old friends. I became a member of TAPPI in 1919, and the organization has provided a remarkable stimulus to the growth of our industry in the last 40 years.

The subject of mill management is so large that it is difficult to decide where to start. The first factor that most think of is the profit motive. We are in business to make money; otherwise we don't stay in business. In our system of free enterprise you must have a profitable venture to attract investors, and the pulp and paper industry is noted for its heavy investment requirements. A new pulp mill today will cost $100,000 per daily ton of production, or $20,000,000 for a 200-ton mill, and that doesn't include the woodlands. Paper mill costs would be roughly one half to two thirds of that figure.

This profit motive has come into considerable disrepute recently due largely to the propaganda of leftist groups; but our system of economy is the best yet evolved, and it is based on that motive. The profit factor is still the mainspring of private enterprise. Young men entering our industry must realize that when they produce profits, all ethical matters considered, they are themselves succeeding and will be rewarded accordingly.

To counteract the claims from Washington that management is always out to beat somebody and make an unfair profit, a number of organizations are hard at work. Their purpose is to sell the system of private enterprise to the people and to correct the misconception about the pereentage of profits realized. The American Pulp and Paper Association has organized a committee to teach paper mill communities how the industry helps them, and how small the profits usually are. The A.C.E.S. (Americans for the Competitive Enterprise System) visit schools, arrange for student trips through the mills, and then present lectures on our country's economic system.

The second important factor in our system of free enterprise is competition. This is the life blood of our industry. It would be a simple matter for mill managers to get together and control prices, but such a course would be both illegal and bad for the industry. To stay healthy the industry must produce more and better articles at less cost. One reason why England is suffering economically now is that their industries were developed under

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e artel system. The textile industry controlled its prices at a vel which assured good profits, regardless of manufacturing sts. The equipment was allowed to become obsolete, and the bers were paid minimum wages. This total lack of com-ti ion made their industries weak and unable to match the pres-t production in other countries today.

We have the elements of such price controls here, beginning th the NRA of the thirties. Ceilings designed to hold down ic s have acted as floors as well as ceilings

The third factor of importance is labor relations. Today an gement makes very few moves without considering this ctor. Even on the installation of labor-saving machinery labor s to be sold on the idea that it will benefit in the long run. In r pulp and paper industry the labor groups are usually not ve se to higher production and greater machine speeds. We ust remember that labor is entitled to part of the profits result-g rom such improvements. The main reason for our better ag levels today is that production per man-hour has increased ea ly in our industry in the last 12 to 15 years.

One of management's main functions is to control costs. In ne al in our mill roughly 55 to 60% of total costs go for raw te ials — pulps, rosin, starch, alum, and other additives. The ct largest single item of expense is labor. We can't keep labor ate down except by increasing the production per man-hour. in s one reason why growth of the company is so important. e need not only to meet the growing demands of our et mers but also to reduce the cost of labor per unit of produc-n. There lies our biggest hope for reducing costs.

Overhead expenses (salaries, pensions, taxes, vacations, bonuses ertising, etc.) are similar to labor costs. All have increased rkedly, and our only way to reduce them is to produce more ds per man or per machine.

Other major operating expenses include power, steam, felts, es, and freight. Total railroad freight costs (in and out) per of paper run up to $30 to $40. Truck shipments help many ills reduce these terrific costs.

One recent expense of considerable magnitude has resulted m stream pollution regulations. Many mills have been re-red to construct equipment to handle their waste water, and installation of such filters involves an appreciable investment. sconsin and Pennsylvania have led most other states in stream lution controls.

Taxes take up 55 to 85% of the profits in Pennsylvania includ-the 3% State Tax. To maintain equipment and expand the nt, while paying such taxes and dividends out of profits, is ough problem. Depreciation allowances run about 5% for a integrated mill and this is not nearly enough for replacement l necessary growth.

A final function of management, and one of the most important, planning for the future. This requires resourcefulness and rtness to catch trends in manufacturing costs and selling ditions, watching what the competition is doing, and growing n our customers and country. We must study the prospec-e market for our products, the potential new sources of raw erials, the needs for additional equipment, the future labor, er, and power supplies, and the availability of capital for new estments.

CUSSION

. Marble: You mentioned that the working class has been cated to believe that management is out to beat the public. you find the same attitude in young supervisors?

. Hanson: No. Most foremen realize management's blems and believe that management is doing the fair thing for mployees. Of course, there are some exceptions to this.

. Marble: Do these foremen educate their workers along se lines?

. Hanson: Not too well. It is difficult to find foremen who talk well and understandably to their men. Many times they to pass along information management wants passed to the kers.

. Haug: That's where management falls down. It hasn't rated the foremen to do this. Management is directly re-sible for such training. It can't pass that responsibility to e outside teacher.

. Brill: Many companies have found it highly desirable to e the workers part owners of the business by means of stock hase plans. How do you feel about that?

. Hanson: That is still a controversial question, but I believe he whole the idea is sound for the future of the American omy. However some companies have found that such an ngement may work against them. Their men buy stock, ex-ing good dividends every year, and when these fail to mate-ze in hard times, the men are upset. There are many argu-ts for both sides of this question.

P. E. NETHERCUT, *Secretary*
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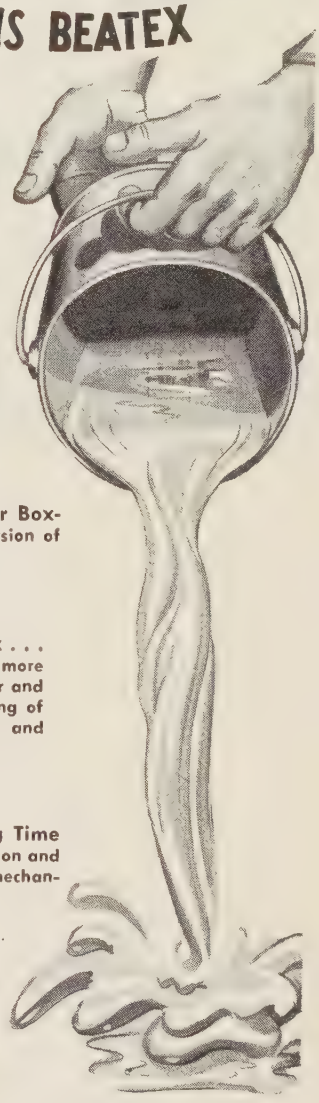

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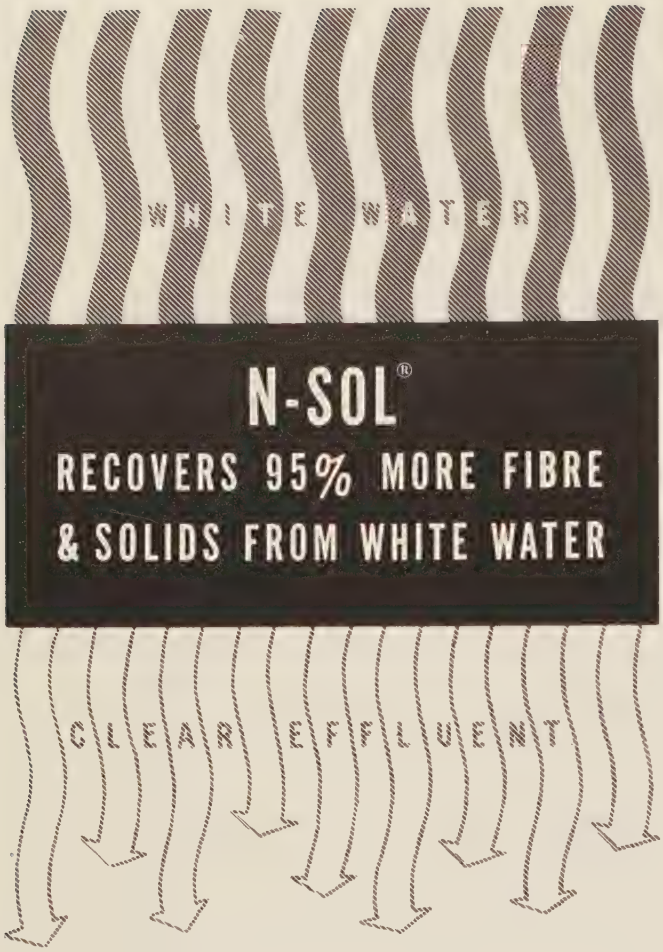

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Chicago

The Speaker at the November meeting of the Chicago Section of TAPPI was Arthur C. Dreshfield of the Chicago Testing Laboratory. His paper follows:

Paper and Board Sizings and the Qualities They Impart

A. C. Dreshfield

Sizing in all of its ramifications is probably one of the most complicated subjects in all papermaking. In spite of its complexity, or perhaps because of it, no textbooks, no monograph, no school of papermaking does it the justice to treat it as a unit operation in a chemical engineering process.

Yet this evening I have accepted your program committee's invitation to discuss the subject before you, primarily as it relates to your business interests, those of paper and board manufacturers, waxers, laminators, bag and carton producers, printers, converters in general and jobbers, dealers, distributors, and users of practically every type and grade of paper product made in the country.

The assignment is not a simple one, and I have considerable misgivings that I may not be able to do it justice, either in the time allotted or before my voice gets weary or my efforts put all of you to sleep.

First let us define size and sizings in the connotation we give those words.

The encyclopedias leave us entirely in the dark. They discuss size, as related to the environmental surroundings which affect the growth of man, the trade custom for establishing the dimensions of children's and adult's clothing, sizing as it relates to the finish and quality of cloth, and sizing in the field of ore dressing which is the classification of particles by their physical shape and dimensions. It is ignored completely as a subject of pepermaking.

Webster partially clarifies but helps confuse us a bit for if we finally wade deep enough into the more obscure definitions of the term—size to that scholarly editor, and I quote "is any glutinous material, any varnish, shellac, or the like used for filling the pores of paper, fiber, plaster, etc."

My suggestion is to forget the academic definitions and assemble a meaning specific to our industry.

Today, to the papermaker and to the consumer of paper products, size can be defined as any chemical, other than bleach, fillers, pigments, and dyes which are added to the papermaking furnish, or subsequently applied after the web is

A. C. Dreshfield, Chicago Testing Laboratory, Chicago, Ill.

The November 17th meeting of the Chicago Section of TAPPI

ned, which alter those characteristics of the sheet that te to its resistance to the transudation or absorption of ids which come into contact with the web.

Sizing, then, is the chemistry and processing of paper prod- to alter their resistance to the passage of liquids into and ugh them.

As far back as history is recorded, the first method of sizing per is credited to the Orientals who found their handmade pers had to be covered with a thin coating of pulverized psum to make it possible to write on them. This was the wn of sizing, and interestingly enough the forerunner of the ept of coated papers for printing.

As early as about 700 AD the Chinese sized their paper by ing it in a starch solution prepared from plant lichens or

It was not until the 14th Century in England that animal was substituted for starch as the sizing agent, and again was applied in a dipping operation.

In 1807, Illig, a German, first conceived of rosin as a base rial for engine sizing, and rosin size has been the backbone zing since that time.

It was not until the period beginning with the 1920's that vances in chemistry and the application of its principles to permaking did sizing emerge from a papermaker's art to a ries of technical processes.

Today we must divide sizing into classes: those applied ile the stock is still in suspension in water, and those applied er the web is dried. For the purpose of this presentation, will limit ourselves to engine size, tub sizes, and calender es, although the term is also applicable to the converting d coating processes performed as operations supplementary paper and board making.

The fundamental sizing agent is rosin size, added to stock tchwise in the beaters, or continuously at a convenient int before dilution at the headbox. The grades and types of in size are legion. They are made from gum or wood rosins m the darkest to the palest color grades, as emulsifiable stes cooked with soda ash or caustic, varying from ones in hich the rosin is fully saponified to ones in which one third of e rosin is unsaponified, or in the form of free rosin as it is lled.

Completely saponified dry sizes are available which may be ded directly to the heater without prior dilution.

And special high free rosin sizes are available in which less an 10% of the rosin is saponified, and over 90% is present as olloidal dispersion of free rosin.

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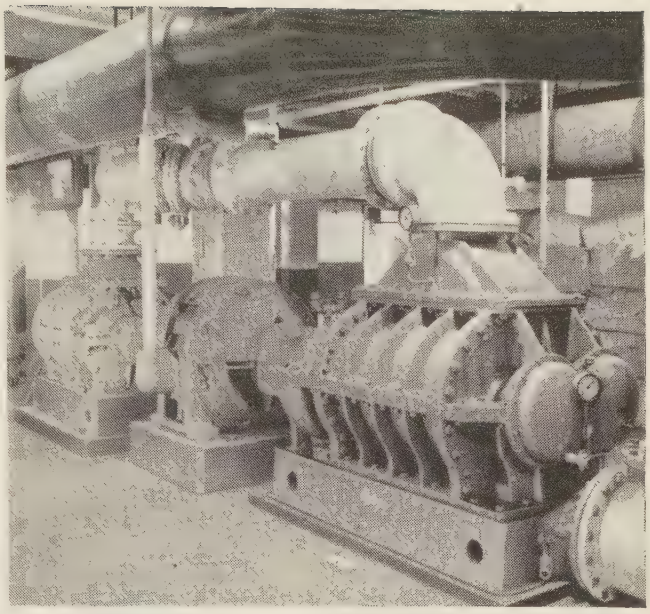

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Each specialty has its place for certain restricted uses—but the great majority of rosin size is consumed as paste or dry size with from 10 to perhaps 25% free rosin added in amounts varying from 0.2% to perhaps 5% of the fiber.

All grades of rosin size, to be made effective must be precipitated onto the fiber with papermaker's alum and alum is specific as no other acid or acid salt is universally effective as a precipitant.

What then does this basic material add to the functional properties of papers and boards? Essentially it imparts resistance to the rate at which liquid water penetrates the web. I stress liquid water, for it by itself adds nothing to the resistance of the web to water vapor, or, for that matter to any other liquid than water, or an aqueous solution or suspensions of other materials.

It converts blotting papers, waterleaf, and mimeograph paper to writing grades.

To the envelope, to the writing tablet, to the bond paper, and ledgers, it makes it possible to write on the surface without having the ink feather and run.

In coating raw stock, it controls the rate at which the water, which carries the coating pigment and adhesive, is absorbed into the sheet. Thus it influences the depth of adhesive penetration and the bond and the tightness of the pigment.

In bag stock, gumming tape, carton board, and test liner, it imparts water resistance necessary for durability and to control the wettability of adhesives.

These are the direct results of rosin sizing—but there are corollary effects.

Remember rosin size must be precipitated with alum—with sufficient alum to make the stock acid—let us say for optimum values to a pH of 4.5 to 5.6. Thus unless special steps are taken, all rosin sized sheets are normally on the acid side. There are, of course, exceptions to all rules, and to this one. With sufficient neutral or alkaline shower water available, the sheet may come off the wire at the neutral point or slightly on the alkaline side. By the use of sodium aluminate and alum, a well-sized sheet can be produced on the alkaline side, at a premium in price. This permits production of antitarnish grades of wrappers, noncorrosive grades of ordnance wraps, and alkaline bag stock for packaging such commodities as cement, which has been found necessary in order to avoid rapid degradation of the bag if the stock is on the acid side.

With the precipitation of the rosin by the alum, a flocculent precipitate is formed, which carries with the size many small fibers which would otherwise be lost into the white water and this also applies to fillers if the sheet is loaded.

What then are the many specific corollary properties of a sized sheet? The sheet is acid hence it degrades with age faster than an unsized sheet. The rosin itself is an unsaturated chemical which lends itself to oxidation and degradation with age. The ordinary papermaker's alum contains iron as an impurity which again reduces the permanence of the sheet.

. C. Dreshfield, Chicago Testing Laboratory

P. J. Massey, St. Regis Paper Co.

At this point, let me add, however, that if permanence is a ctor, the use of a size made from hydrogenated rosin, pre-pitated with iron-free alum, and sodium aluminate, at or ove the neutral point, does permit production of a sized eet, which ages very well. This is the method used to size e more durable bond and rag grades required for permanent cords.

The size precipitate has neither appreciable tensile strength r flexibility, hence the strength and physical properties of a ed sheet are not, let us say, improved. They are lessened in portion to the amount of size used in the furnish.

Let us return to the concept of the size helping retain more ort fibers and filler. Here size indirectly helps the printer, thus, it makes a smoother, better surfaced, better formed eet although it adds nothing to the resistance of the sheet the penetration of any ink made from a vehicle other than ter. Thus sizing does not directly affect the penetration of ks in which mineral spirits, oils, and varnishes are the hicle.

There are definite limits of the capacity of rosin size to im-ove water resistance. The limit is a function of the grade pulp used, the amount of refining given the stock, and the ount and type of filler in the furnish. As a general rule, e more impure the fiber, the easier it is to size, groundwood, tural kraft and unbleached sulphite being the easiest to hard e.

The purer the cellulose of the fiber, the more difficult it is to e, bleached grades, alpha, and rag being the most difficult to .

Loading, too, makes sizing more difficult to obtain, and identally, a calcium carbonate loaded sheet is almost im-ssible to size with rosin since it reacts as an alkali with the m and prevents reducing the pH sufficiently to yield opti-m rosin precipitation.

Furthermore, addition of size in small amounts is more eficial than in large dosages. Most grades can be sized h from 1 to 3% of rosin. Above 3 to 4% rosin little addi-nal sizing develops and many papermaking difficulties re-.

Rosin size then controls the rate at which water penetrates ough the web, but it does not affect the total amount of er a web will absorb by immersion. To accomplish that, it uires other beater additives, or later chemical treatment of web. This brings us to other beater sizing additives.

till for the purpose of increasing resistance to liquid water, re are several common materials used. The most com-n supplementary chemicals are the petroleum hydrocarbon ces, usually the crystalline paraffinic type, but, in some es, the microcrystalline type.

uch waxes for engine sizes are either added separately as lsions of the base wax, as emulsified mixtures in high free-n size emulsions, or incorporated into dry size.

ngine sizing waxes all markedly increase resistance to

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water penetration but only slightly to printing ink vehicles. Specifically microwaxes are very effective in improving the blood resistance of butcher papers and meat wrappers.

Wax sizes also impart a noticeable degree of surface water repellency when used as a sizing agent. Additionally, they do impart a smoother surface, possessing less fuzz and more gloss, and thus are indirectly beneficial to printing grades.

Normally, the amount of wax which can be added in engine sizing is limited to 0.2 to 0.5% of the stock, as above this amount, spotting and press roll accumulations result, and the sheet becomes too slippery to handle well on the calenders, and in piles after the slitter and cutter.

As a strict specialty, stearic acid, a fully saturated waxlike animal fat, is used in the form of its sodium soap, along with iron-free alum as the precipitant in the sizing of photographic papers. In such papers, the unsaturated nature of rosin, its reactivity with certain chemicals used in photographic emulsion coatings, and the iron in ordinary papermaker's alum, preclude the use of any rosin size in such grades.

To impart a high degree of water resistance, especially in grades where color is not important, two resinous materials are commonly used, asphalt and Vinsol resin.

Asphalt emulsions are used as an engine size in the production of many grades of news and chip-filled, lined boards where high water resistance, low water absorption, and some degree of water vapor transmission resistance are required. Examples of such use are in the production of carton board for packaging slightly hygroscopic materials such as soap chips and built detergents so widely used in domestic cleaning and washing operations.

For still harder board sizing, for stiffening, and for mild oil resistance, especially for the hard calendered types used for automobile panels and for V-board production, pulverized asphalt or Vinsol are added directly to the beaters, literally as a filler and loading, which bind the fibers together with a waterproof, oil-resistant coating, when these materials fuse as the web is run through the driers.

To summarize at this stage, rosin in various forms, waxes, asphalt, and Vinsol resin are the common beater sizing agents which impart varying degrees of water resistance, water repellency, and limited degrees of oil resistance and lessened water absorptiveness.

To serve a still different function, certain resins are added as an engine size to impart improved strength properties when the web is wetted with water. Two classes of such wet-strength resins are in common use today, one being the melamine resins, the other the urea-formaldehyde type. Both types are added directly to the stock while still in suspension, in amounts varying from 0.5 to 3.0% of the stock. Both types are heat-converting which means they do not develop their wet strength until after the sheet is thoroughly dried, and in many cases, aged while in storage, in rolls or bundles.

Wet strength in varying degrees is desirable, and in fact practically mandatory today in such grades as twisting tissue, towelling, butcher wraps, loin papers, freezer papers, in many grades of bag stock and carton liners, ice-cream, oyster pail, and milk carton boards.

As an aside, the better a sheet is sized, the less desirable it becomes as a wastepaper for reuse in board manufacture. Hard-sized sheets sized with rosin size along are nonobjectionable, but wastepaper and board containing larger quantities of wax, Vinsol resin, and especially asphalt and extreme amounts of wet strength resin, are black-listed and outlawed as waste grades for reconversion to paperboard.

Two other beater additives deserve mention as supplementary sizing agents invariably used in combination with rosin size, silicate of soda and starch.

Corn mainly and to a lesser extent, potato and tapioca starches are commonly added, either in their raw state, or solubilized by boiling, by enzyme conversion, or by pretreatment with acids, alkalies or oxidizing agents. The starches add no increased water resistance and but little oil

resistance, but rather increase the physical properties especially burst and tearing resistance to a limited extent, reduce fuzz and improve erasability, feel, and rattle, and produce smoother calendered sheets. Thus they are effective sizing adjuncts in grades of writing and printing papers, and in the top liners of carton board where printing is usually a subsequent step.

Silicate of soda is specifically added where increased stiffness and rattle are desired in such grades as bristols, card and tag stock, and in some instances in meat tray boards, test liner, and corrugating mediums.

Casein, glue, and the maleic adducts of rosin have at one time or another been used to improve the efficiency and retention of rosin size, but their value is doubtful in view of their comparatively much higher cost per pound and questionable retention in the sheet.

Casein, of the three, is of some value in improving the rosin sizing of Yankee dried tissues especially if the stock is harshly refined rather than refined by beating.

Glue has been known to aid the retention of the more costly fillers such as titanium.

This closes the list of the more fundamental commonly used coater and engine sizing agents.

Next, in the list, and next down the papermaking process are the tub-sizes. As all of you know, the size tub or size press is located about two thirds the way down the drier section.

The equipment used for sizing at this point may be a dip pan with squeeze rolls or a nip at which the sizing chemicals may be applied as a spray or shower onto either or both sides of the partially dried web.

It is at the size press that the special effects and properties are incorporated into the sheet. Here the chemist, chemical engineer, and technical service engineer of the chemical supply houses are in their glory. Here is where advances in chemistry are kept under the belt, held as only the papermaker can hold a subject as a trade secret, and a closely guarded one at that.

The literature and textbooks are woefully behind times in their disclosures. The textbooks tell of the age-old size press applications; animal glue alone or with alum or formaldehyde to produce blueprint, map stock, and high grade bond sheets; boiled or converted starches for finish, feel, character, and writability in tablet, writing, bond, and ledger grades; and in more recent texts, wax emulsions to provide water resistance, water repellency, finish, gloss, and smoothness.

But the list of chemicals which can be added at the press alone or in combination almost defy the imagination.

All the sizing agents used in engine sizing, excluding asphalt and rosin size, are potential tub sizing chemicals. At the press they may be blended, modified, and combined, and applied in a wide range of weight per ream. The amounts applied can be varied by the concentration of the treating solution, its temperature and viscosity, the pressure on the nip, the speed of the machine, the nature of the stock, the manner in which it has been refined, its sizing, porosity, and the moisture content of the web as it enters the press sections. Most attractive, from a cost angle, the chemicals applied at the press are entirely retained in the web, and white water losses are eliminated.

Literally dozens of chemical combinations have been developed and are used in the production of specialty grades. The list includes glue, casein, alpha protein, corn protein, soya bean flour, starch, wet-strength resins, wax emulsion, silicates, phosphates, antimony compounds, natural and synthetic gums, synthetic resin emulsions, methyl cellulose, carboxymethyl cellulose, kelgins, alginates, Irish moss, glycerine, glycols, dextrine, sugars, complex metallic organic compounds such as stearato chromic chloride, the silicones, preservatives, biocides and fungicides, and probably dozens of others which have slipped my memory or which have not come to my attention.

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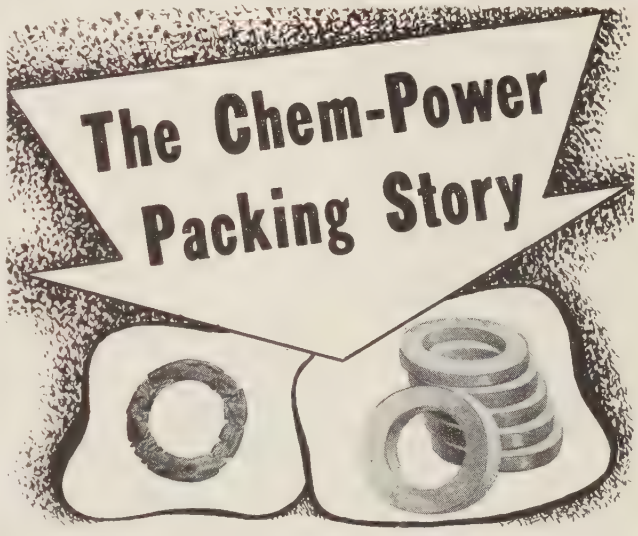

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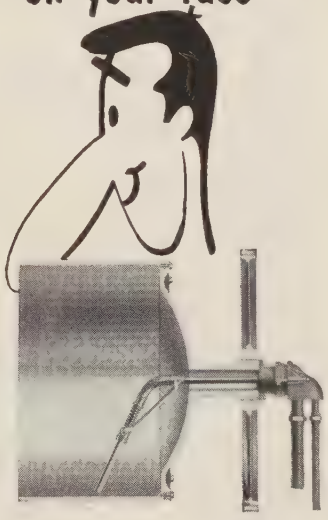

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Let us quickly scan a few of the properties which can be imparted by tub-size applications:

Glue and starches increase burst, tear strength, folding endurance, scuff resistance, erasability, reduce fuzz, and increase smoothness.

Resistance to the flow of fluid water is increased by formaldehyde treated glue, resin treated starches, and wax emulsions. Water repellency results from the use of wax emulsions and stearato chromic chloride.

Blood resistance is improved by microwax emulsions.

Antistick and water repellency is imparted by the silicones, and grease and oil resistance is imparted by glue, casein, or protein and similar hydrophilic nitrogenous materials, and the cellulosic derivatives.

Porosity is altered and the rate of gas and air permeation increased by wax emulsions, starch, the cellulose derivatives, the kelgins, and the alginates.

Softness, drape, and folding endurance are improved by the humectants such as glycerine, dextrine, the invert sugars, and the glycols.

Fire-retardant properties are imported by the silicates, phosphates, antimony salts, and complex organics such as sulphamic acid and its salts.

Mold and fungus resistance is obtained by the use of a wide variety of complex organic chemicals marketed by the well-known chemical concerns.

The list is almost infinite. Find mixtures which are chemically compatible and practical from a cost and operating angle and the papermaker can build any combination of specialty attributes into the sheet. It is at the size press that specialty grades are developed: cup stock, meat tray boards, butcher wraps, delicatessen papers, paper drapes, and dozens of other grades.

If the consumer wants standard grades of paper, any mill can provide them; if specialties are wanted, look only to mills equipped with size tubs and size presses. Tell them the properties you want, and the price limitations, of course, and the odds are they can provide you with an acceptable grade. Don't however, make the mistake of asking how they make the grade and what chemicals they use; that is their secret and rightfully so, to protect the time, the labor, the headaches, and the broke they made while developing and formulating the treating dope.

Last in our list of sizes are those applied at the calender stacks. Essentially, the list can theoretically include any chemical or combination applied in a size press, with several obvious limitations and exceptions.

The size press is followed by additional drier sections where heat conversion is possible and excess water can be driven off. The calender stacks are at the end of the drier section. Any liquid must be applied there in restricted amounts and only with that amount of water which can be absorbed without harm to the web. Furthermore, tacky, adhesive or abrasive materials which foul the stacks must be avoided. Thus, practically, calender sizes are limited essentially to the application of small amounts of water alone, silicates, starches, wax emulsions, corn protein emulsions, kelgin, and the cellulose derivatives.

One organic not capable of use in the beaters or size press is oil which can be applied at the stack for food wrapper grades.

Each of these chemicals impart their characteristic fingerprint on the properties of the sheet, to the limited extent that fractional amounts are applied in pounds per ream.

No discussion of sizing can be complete without some mention of the testing methods used to detect the effect on the properties desired to be controlled. Actually, testing for the effect of treating chemicals, as you can see, must include dozens of common physical and chemical tests, such as burst, tear, fold, erasability, and pH.

However, less standardized testing methods are involved in measuring the permeability of the web to liquids. Here the papermaker and the consumer must be resourceful, and the

st rule to follow is to test the web against the medium it is sired to resist. This phase in itself is broad and long ough to justify an entirely separate consideration.

Pacific

The Pacific Section met at Camas, Wash., on Nov. 18, 1952, with an attendance of 143.

Don Platt of Crown Zellerbach Corp., Camas, Wash., was Program Chairman for this meeting and arranged an excellent program which is described in this report.

Crown Zellerbach Corp. held open house in their new development laboratory from 10:00 a.m. to 1:00 p.m. This was followed by a technical session from 2:00 to 4:30 p.m. At the conclusion of the technical meeting, Crown Zellerbach Corp. was host at a reception at the Crown Zellerbach Inn.

This was followed by dinner at 6:30 p.m. after which E. Gilbert de Luccia, Vice-President, Pacific Power & Light Co., Portland, Ore., gave a very interesting and timely talk on the Pacific Northwest power situation.

D. G. Felthous, Plant Engineer, Longview Mill, Pulp Div., Weyerhaeuser Timber Co., presented a paper entitled "Problems of Exterior Maintenance of Pulp and Paper Mill Buildings." Following is an abstract of his paper.

In general, the paper covers the maintenance of building walls, doors, and windows, exterior stairways, and downspouts.

Exterior of buildings are subjected to a great deal the same corrosion as equipment and building interiors.

Some of the newer methods and materials for covering deteriorated concrete walls are discussed. Comparative costs and maintenance of steel, aluminum, and stainless windows are given. Methods and materials used for the best possible maintenance of outside steel are examined and costs of various materials for downspouts are compared.

Four things must be kept in mind where coatings are used for maintenance purposes: (1) proper surface preparation, (2) choice of proper coating, (3) proper application of thick enough covering (at least 5 mils), and (4) proper routine inspection and repairs to coverings.

A paper prepared by Morris R. Rivers and Kenneth Linehan of the Crown Zellerbach Corp., Camas, Wash., entitled "Our First Year with a Hot Lime and Zeolite Feedwater Treatment Plant" was presented. Following is an abstract of their paper.

Paper machine speed-ups and the use of higher pressures in the driers, plus additional steaming loads throughout the mill, caused our boiler steaming rate to increase materially. This increased steaming rate plus a high percentage of make-up of a high silica content was more than the boiler tubes could take. As a result we experienced 90 tube failures in 4 years.

It was decided to install a hot lime and zeolite feed water treatment plant having a capacity of 72,000 g.p.h. The system consists of a composite (condensate plus quenching water) receiver, make-up sand filters, sedimentation tank, five pressure filters using anthracite coal, four zeolite cells employing a coal bed, and 201 cu. ft. of the new type high-temperature polystyrene resin zeolite. The sedimentation tank is supplied with and maintained under a steam pressure of 5 p.s.i. The tank is also supplied with lime and MgO in slurry form from two gravimetric loss of weight type feeders. The filters are equipped with back wash connections: and the zeolite cells with the necessary brine regeneration accessories.

The system was put on the line Aug. 4, 1951. It has been necessary to change many of the beginning rules and schedules. Records have been kept from the first day so we have complete charts of hardness reduction, silica removal, chemical usage, and the zeolite regeneration.

We had mechanical difficulties, but they were only minor. On the whole, we are quite happy with the system and the job it is doing. We have not experienced a single tube failure since the plant has been in operation and an internal inspection found the boilers "clean."

Harold Hilton of Northwest Copper Works, Portland, Ore., presented a paper entitled "The Development of Fabricated Stainless Steel Pipe, Fittings, and Valves in the Pulp Industry." The abstract of his paper is as follows:

With stainless steel being produced in sheets and plates in a greater quantity and in a wide range of corrosion and heat-

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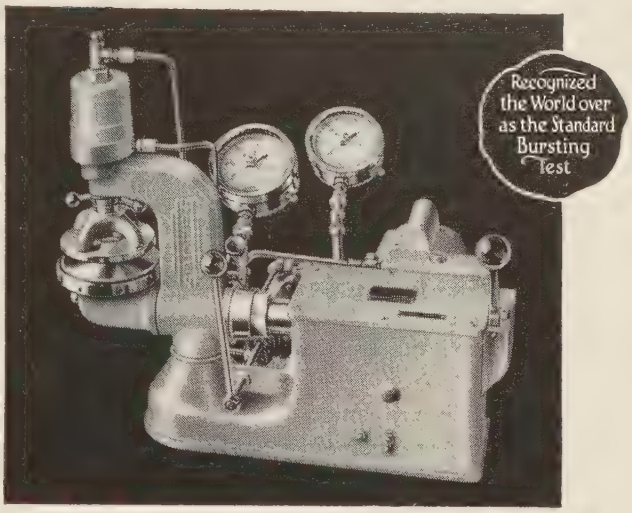

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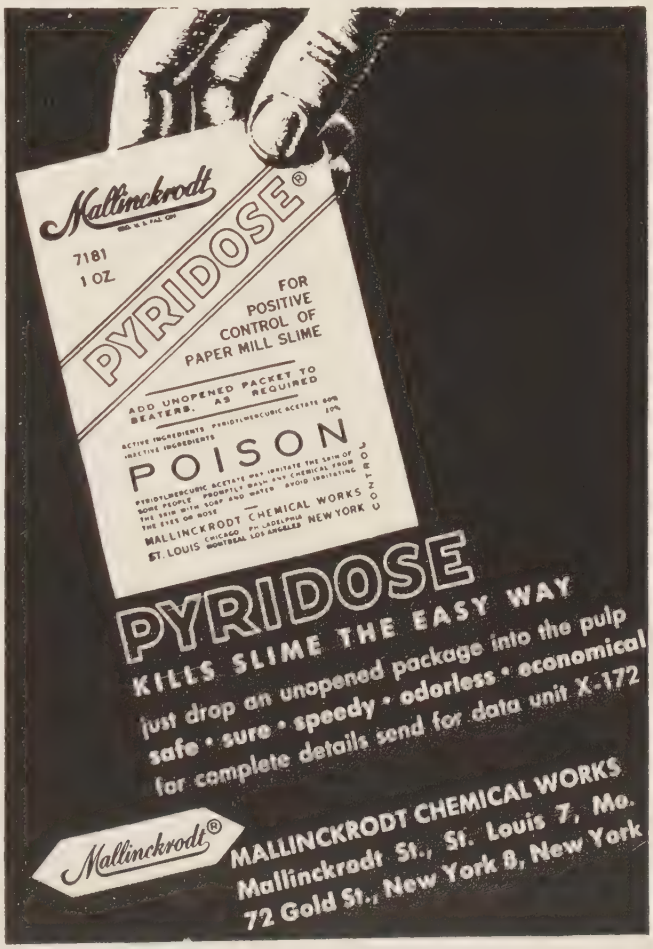
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resisting types, new and extensive uses have been found. Thin wall stainless steel pipe and fittings have been used to replace older installations and for new piping layouts because of superior resistance to corrosion, aid in maintaining cleanliness, and ease of handling during installation. Gate valves, stock valves, and other valves were designed to be fabricated from stainless steel.

Using proper welding and assembly techniques, which include either annealing or using the quench welding process, excellent results are obtained in gaining anticorrosive properties in fabrications. The fabrications from stainless steel sheet and plate enabled the cutting of costs in low pressure process piping assemblies and made possible the design and utilization of more complex structures.

Further advances in the fields of design and fabrication of complicated stainless steel equipment can be accomplished and corrosion resistance maintained if attention is given to the constant development of new welding processes and assembly procedures.

Raymond P. Hill, President, Chemical Proof Construction, Inc., Seattle, Wash., presented a paper on "The How and Why of Protective Coatings."

H. B. Petersen, *Secretary*

Our First Year with a Hot Lime and Zeolite Feedwater Treatment Plant

M. R. Rivers and K. J. Linehan

Every new installation is an attempted solution to some kind of a problem, whether it be a demand for bigger and better atoms or merely cleaner water. The problem behind our installation of a boiler feedwater treatment plant may not have been apparent to outsiders, but I assure you these problems were only too real to the steam plant operators.

Before 1947 the steam demand on the boiler plant was such that, with internal chemical treatment and blowdown, it was possible to keep the concentration of the water impurities in the boilers to a low enough point that no danger of deposits was incurred. This was also made possible by the fact that the raw water make-up at this time was only about 40%. With the advent of paper machine speed-up, however, and the use of higher pressures on the machines, it was necessary to quench the flash steam from the driers before it could be pumped back to the steam plant. This quenching is done with raw water and hence the amount of contamination was increased materially. We had make-up water sent to us at a rate as high as 70%.

Take the installation of additional direct steaming kraft digesters plus machine speed-ups, add two modern boilers with their high rates of heat absorption, combine this with a high percentage of make-up containing a high silica content, and you have the causes. The results, of course, were one tube failure after another.

In this period starting with the mill expansion until the installation of the treatment plant, our records show approximately 90 tube failures scattered among our various boilers. It would be safe to say that these 90 failures caused 60 unscheduled boiler shutdowns with resulting low steam output.

Our avenues of solution to this problem were rather limited, as we had but two choices. We could revamp the entire condensate system, permitting the return of only pure condensate and installing a small treatment plant for make-up; or we could go to a larger pretreatment plant, and thus delay revamping the condensate system until found necessary due to further expansion.

The foregoing has been a rather hasty sketch of the situation up to the planning stage of our treatment plant.

The planning itself consisted of several meetings with experts and having representative analysis of our raw water from our several sources sent out with the request for proposals, estimates, and guarantees. From these requests we received ten proposals from three different manufacturers.

M. R. Rivers and K. J. Linehan, Crown Zellerbach Corp., Camas, Wash.

The receipt of these proposals merely crystallized the thinking that the hot lime zeolite process was the system we wanted. Thus the engineering wheels were put into motion and in a short time we had a 72,000 g.p.h. hot lime and zeolite process that was guaranteed to produce an effluent containing not more than 2 p.p.m. total hardness and not to exceed 2 p.p.m. silica.

Composite water (condensate plus quench) returns to our immediate control at a point known to us as no. 3 hotwell. Located directly under this receiver are the sand filters which supply the make-up water to the system. From no. 3 hotwell the water is pumped directly to the sedimentation tank through a control valve. The effluent from the sedimentation tank flows by gravity to and through the filters. From the filters the water is pumped to and through the zeolite cells to the delivery pump which sends it to the deaerator and thence to the boilers.

With the over-all picture in mind let's return and look at some of this equipment a little more closely. Number 3 hotwell is merely a condensate receiver operating at atmospheric pressure. It has a temperature range of between 160 and 180°F., with an automatic level controlled make-up valve. The make-up sand filters are of conventional horizontal design employing graded filter aggregates ranging from fine sand to $^1/_2$ to 1-in. gravel. Following the flow from this point through the pump we find the next piece of equipment is the indicating and recording meter-controller. This controller sends the necessary operational impulses to the two chemical feeders and also to the sludge blow-off valve. The chemical feeder is of the gravimetric loss of weight type. The timers can be set for a varied period of operation after the passing of a predetermined quantity of water. The passing of the required units of water causes the controller to send out the impulses that set the equipment into action.

The chemical feeders are merely a hopper with feeding mechanism attached, mounted on scales. The hopper is filled with material and the scales are then manually balanced. The free-moving end of the scale beam then controls the rate of feed.

The automatic sludge blow-off valve is also operated on the time impulse basis, the units being approximately 4000 gal. and the timer having a present setting of 80 or approximately 320,000 gal. to set the valve in motion. The valve is air-operated with a solenoid control on the air, and it stays open for a period of one minute.

Back now to the controller, we follow the flow through the main flow control valve. This valve is a standard air-operated water level controller, and discharges directly into a multiple spray nozzle in the top of the sedimentation tank.

The nozzles, of course, serve to divide the water particles minutely. Steam is also supplied at approximately this same point, directly into the dome of the tank. The tank is maintained under a steam pressure of between 4 and 5 p.s.i., reduced down from 150 p.s.i. The steam after entering the tank is directed against a baffle and deflected into the water spray, thus causing an effective mixing and heating. The noncondensable vapors are vented through a valve in the dome of the tank.

The tank itself is 25 ft. in diameter and 47 ft. high, having 23-ft. straight sides, a conical bottom, and domed top. It is mounted with safety valves and six 12-in. vacuum breakers, plus connection for sludge recirculation venting and overflow. The tank is designed for an internal pressure of 10 p.s.i. and is, therefore, of noncode construction. The total weight on the foundation, including water, is approximately 478 tons.

Suspended in the approximate center of the tank is a large cone with an open bottom and the apex up. Connected to the top of the cone is a vertical pipe which is blanked off on the upper end with the main effluent discharge connection out of the side. Perched on the top of this pipe is the deflector for the filter backwash discharge.

The two chemical lines enter the tank above the water line and spray down in about the center. The chemicals, water, sludge, and sludge, all combine in the area directly above the cone. In this same immediate area the chemical reaction (precipitation of $CaCO_3$) and the adsorption of silica start and carry on as the precipitant flow moves down and out. This direction of flow continues until it reaches the lip of the cone and then it travels straight down. The effluent is thus forced to flow up under the cone, up the pipe, and out the discharge.

In our case the main purpose of the sedimentation tank is to remove the silica and to reduce the hardness of the water. The hardness is reduced to a point whereby it would be economically feasible to remove the rest of the hardness by the zeolite process. This point is considered to be at about 38 p.p.m. when the entering hardness is about 66 p.p.m.

The reason for combining the processes of hot lime and zeolite is that the hot lime sedimentation can cut the total hardness approximately in half rather rapidly, but it would not be feasible to attempt to get zero hardness. The sedimentation is also excellent for the removal of silica, which was one of our main problems, being that our raw water contains approximately 35 p.p.m. silica. With the zeolites, however, it is possible to obtain nearly zero hardness cheaply, relatively so, i.e., if the hardness is within the range of 20 to 30 p.p.m.

The effluent leaving the sedimentation tank at the top of the cone flows by gravity plus 5 p.s.i. pressure on the tank directly to the filters. We have five pressure filters operating in parallel. The filters are filled with varying grades of anthracite coal. Coal is used instead of sand and gravel because of the possibility of adding silica to the water and because coal is easier to fluff with lower backwash flows. These filters remove any trace of sludge that may have carried over from the sedimentation tank. The effluent flow through the filters is from top down, thus depositing the sludge on top of the anthracite bed.

When it is found necessary to backwash the filters, the effluent valves to and from the filter are closed and the two wash valves opened. The backwash pump takes its suction from a line that is extended up under the cone of the sedimentation tank and discharges back into the tank above the top of the cone, thus saving water and heat and merely adding additional sludge recirculation. We attempt to backwash each filter daily when carrying loads of 12 million lb. or more per day as we have the last several months. The backwash is accomplished from the bottom of the filters up. Samples of the backwash effluent are taken and the wash continued until the effluent is sludge-free.

The treated water leaving the filters is picked up by a booster pump and sent to the zeolite cells. We have four zeolite softeners operating in parallel. These softeners are 8 ft in diameter by 5 ft. high, and each contains 101 cu. ft. of a new type high temperature polystyrene resin zeolite supported on a bed of anthracite coal. The principle of operation is an ionic exchange of calcium and sodium. The zeolite removes the calcium from the soluble compounds contained in the water and replaces it with sodium. The resulting water is nonscale forming and has a pH of about 10. When the zeolite is exhausted, it is regenerated by passing a 65% solution of sodium chloride through it. The calcium and sodium again change places, thus restoring the sodium in the zeolite. The calcium chloride is then dumped to the sewer and the zeolite rinsed to remove the chloride. The zeolite is then ready to remove more calcium.

Salt is shipped to us in carload lots and dumped directly into the storage tank. Water is added to this tank daily to maintain a saturated solution of NaCl. From the storage tank the 100% salt solution is pumped to the measuring tank. When it is necessary to regenerate the zeolites, the solution is pumped from the measuring tank to the cells. A line take-off from the pressure side of the delivery pump is connected to this brine line, and thus the solute is diluted to approximately 65% before it reaches the zeolite cell. The regeneration retention time will be discussed later.

Our pretreating plant was put in operation Aug. 4, 1951. A brief indoctrination course had been given by the manufacturer's representative and some written rules made out. Then we were on our own. For the first couple of months we sort of "followed our noses," gradually a pattern of operation evolved. As was planned originally the main operation was set up on an 8-hr. day, 7 days a week, manned by a water treatment analyst and an operator. The assistant shift engineers were given brief operational instruction and assigned to the checking of the treating plant for the remaining 16 hr. of the day just to be sure it kept moving on its plotted course.

As might be expected some of the originally established rules did not fit in with our operation. We started out with the idea that it was not necessary to backwash our anthracite filters until the gage indicated a differential of a 10-ft. head. This rule was followed once, with the disturbing result of sludge carrying over into our zeolite softeners and prematurely exhausting them, and it took about a week of daily backwashing of both filters and softeners to clean up the mess. That experience established the rule of backwashing before the differential exceeded a 4-ft. head.

The above experience showed that a definite change in the periodic operational schedule had to be worked out. Thus both the operational and control log were modified. Through the use of this log a very fine record of the past year's results has been obtained. We are thus able to compare our operation with other plants and also able to check against the manufacturer's specifications.

HARDNESS REDUCTION

From this record, charts have been drawn showing graphi-

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cally what has happened. The first chart showed the comparative hardness of the incoming waters, and the resulting reduced hardness in the water delivered to the boiler. We have considerable variation in the supply being received from our two sources, Lakamas Lake and the Columbia River. Except for the winter months these two sources are mixed in varying percentages depending largely on the lake level. As the chart indicates our winter supply from the lake had the lowest hardness, reaching a low of 10 p.p.m. A high of 78 p.p.m. was reached in late summer when our supply was 100% river water.

At present we have a situation where our paper machine condensate is polluted with quenching water. As a consequence all our returning composite water is being run through our treating plant. This water has a hardness variation of 6 p.p.m. in February to 46 p.p.m. in August.

During the first few months' operation we had considerable difficulty in obtaining a proper sedimentation mat, a condition we have found imperative for good operation. Our results during this time fluctuated considerably to say the least. Around the first of October, however, we started our MgO injection for silica removal, and found in addition that our flocculating difficulties also ceased. From that time on we have been able to obtain an average effluent hardness from the sedimentation of 20 to 25 p.p.m.

The effluent hardness is greater than either the raw or composite hardness during the winter months. This of course is the result of treating condensate along with raw water instead of sending condensate directly to the deaerator. Since chemical feed to the first stage is controlled by the volume of water going to the sedimentation tank and since it is necessary to maintain a fixed amount of alkalinity in the effluent from the treating plant, an increase in hardness results.

Except for 11 days out of the year we were able to obtain the zero hardness expected from the treating plant with the highest effluent reading reaching 3 p.p.m. total hardness.

SILICA REDUCTION

Originally it was felt that silica reduction would only be necessary while lake water was being used as this water showed the highest initial silica content. As a consequence MgO was not used until lake water usage started about the first of October, 1951. The results were immediately satisfactory and, as stated before, the MgO has an additional value of creating a good flocculating action in the sedimentation tank. There was a very satisfactory silica reduction except for a brief period during July when we attempted to get along without MgO. Our tests show that we have been able to keep the silica content of our boiler water below the ASME limit of 60 p.p.m. while maintaining a total boiler concentration of 1200 p.p.m.

ZEOLITE REGENERATION

When the treating plant was put on the line, a regeneration cycle was set up by the manufacturer's representative. At that time apparently exact information on regenerating this new type of zeolite had not been obtained. As a result until late in February, when we went down for an inspection, we were forced to regenerate considerably more than should be necessary with resulting high salt usage. Information then came through showing pilot plant regeneration results. At that time we set up the cycle now being used. We found that we were not exposing our zeolite for a long enough time at a high enough concentration of brine. As the regeneration chart indicates we inject the brine (65% concentration) in 15 to 20 min. and apply a slow rinse or dilution water through the brine distribution lines for from 40 to 45 min. with the idea of keeping the brine in the zeolite for 30 min. at a concentration of over 30%. When the slow rinse is completed a fast rinse begins and is completed when the hardness test shows zero and the chlorine shows less than 26 p.p.m.

As would be expected we ran into mechanical difficulties as well as chemical.

The automatic blow-off valve on the sedimentation tank was originally installed with a reversible motor-operated-valve controlled by relays operated from the inlet flow controller. Due to the ever-present vapor from the sewer under the sedimentation tank, the motor on this valve had a rough time. After burning out twice it was decided to replace it with an airhead controlled from a solenoid-operated air valve. The solenoid was connected to the controller relay. Since that time this piece of equipment has performed satisfactorily.

Every process seems to have a weak link. The chemical feeders seem to be the weak link in our treatment plant. This, however, is to be expected when any piece of equipment as delicate as these feeders is required to be kept in continuous operation. The vibration necessary for operation causes considerable wear. We have attempted to institute preventive maintenance which we hope will reduce the outages. The purchase of a standard household vacuum cleaner was found to be of great help in cleaning and maintaining these feeders.

It has been found advisable to backwash the chemical lines and check the chemical hoppers daily to prevent plug-up of the lines and hang-up in the hopper. Even with these precautions the chemical lines still scaled up badly. It was found possible, but rather difficult to clean the lime lines without removing them. On the MgO line, however, it was necessary to install new lines and clean the old ones at a later date.

We have described as thoroughly as time permitted the operation and experiences of our first year with this type of feedwater treatment plant. The troubles, as you probably noted, were only minor. On the whole we have been quite happy with the job it is doing for us and the results we see in our boilers. We have not experienced a single tube failure since the pretreatment plant was put into operation, and this is a far cry from the 20 odd failures we were having each year. Upon inspection the boilers were found to be scale-free, the old scale has been removed and no new scale has formed.

Empire State

Metropolitan District

The Metropolitan District of the Empire State Section held its regular meeting on Nov. 12, 1952, at Fraunces Tavern, New York, N. Y. Over 90 members and guests were present.

P. L. Haggerty, Chairman, introduced a number of distinguished guests including L. H. Flett, Past-President of the American Institute of Chemists, J. A. DeCew, well known as the dean of size technologists, and three European visitors, P. Frolich of Norway, P. Lusseyran of France, and R. A. DeBussy of Holland.

The technical program comprised a panel discussion on the use of synthetic latices in paper. R. L. Steller of the B. F. Goodrich Chemical Co. discussed nitrile rubber latices, E. J. Heiser of Dow Chemical Co., the butadiene-polystyrene latices, and J. S. Hickman of the Rubber Chemicals Division of Du Pont the chloroprene latices.

All the talks were illustrated with numerous samples which were available for detailed examination following the interesting question and answer discussion period.

An abstract of Mr. Steller's talk on "Nitrile Rubbers for paper Treatment" follows:

Nitrile rubber latices are water emulsion systems of a man-made rubber based on acrylonitrile and butadiene monomers. They are interesting in the paper field because of their good adhesion to cellulose, excellent compatibility with polyvinyl chloride resins, nitrocellulose, phenolic resins, urea formaldehyde resins, casein, and starch. These latices are very interesting because of their grease and solvent resistant properties.

Hycar latices, produced by the B. F. Goodrich Chemical Co., are the most widely used latices in the nitrile field. Hycar latex is used in paper saturation, paper coating, wet addition (beater addition), and in many miscellaneous paper applications such as tie coat adhesives, etc.

Hycar latices are furnished with adequate antioxidants already added. In most paper applications there is no need for further compounding by the customer.

Synthetic Latexes for Paper Coatings

Edward J. Heiser

While preparing for this meeting, I thought I would talk primarily on the use of latex in size press coatings—which is our most recent development in the paper coating field. But since some of you may not be too familiar with the applications of latex in paper coatings, perhaps a review of some of the properties obtained by the use of latex is in order. I might add that these observations are based on our experiences with the use of Dow Latex 512-K.

Latex has been accepted as a pigment binder because it contributes properties which are not usually obtained with starch or casein alone. First of all, latex is an excellent pigment binder. This was determined in a parallel series of printing tests in which the latex proved to be approximately equivalent in adhesive power to casein when freshly coated and superior to casein after 30 days' normal aging. But that is where the similarity between latex and casein ends, because unlike casein, latex contributes resiliency to the coating. This resiliency distributes the stresses applied to the coated sheet during printing more evenly, thereby increasing the resistance of the body stock to splitting during printing operations. Also, unlike starch or casein, latex is thermoplastic which means it softens slightly when heat is applied. For that reason, a pigmented coating containing latex flows readily under the heat and pressure of supercalendering, which results in a smoother, glossier, and more compact coating than is normally obtained with other adhesives. This improved smoothness means that you can get a more faithful printing reproduction and better lacquer and varnish holdout. But since latex is slightly thermoplastic, the coating is more sensitive to supercalendering pressures than is normally the case with regular adhesives, so that supercalendering pressures must be adjusted according to the type of coated surface desired. For good color, good opacity, and good ink receptivity, the sheet should be lightly supered. On the other hand, for gloss-ink printing, over printing, or where exceptional smoothness and gloss are desired, a heavy calendering should be used to compact the coating.

Another difference between latex and starch or casein is that the latex particles do not contain any water to keep them dispersed. In other words, the latex is not in solution form like starch or casein which means the latex particles do not shrink as they dry. This is an advantage for a one-side coated sheet because the tendency toward curling is greatly reduced. Furthermore, the latex does not require moisture for flexibility like starch or casein, and for that reason, the coated paper retains its flexibility and freedom from curl under changing humidity conditions. The latex particles are nonhygroscopic, thus improving dimensional stability and reducing the possibility of misregister in multicolor printing, especially offset printing. The use of latex in a pigmented starch coating also contributes improved wet rub resistance in addition to flexibility. Our work in the machine coating field with actual commercial production has shown that the amount of wet rub resistance obtained with a 50% replacement of the starch adhesive is sufficient for offset printing.

Our most recent development in the paper coating field is the production of a semicoated paper with latex/starch and clay at the size press. As many of you know, the idea of applying a pigmented coating at the size press is not a new one. It was tried in the early days of machine coating using coating mixtures of low solids content. A present-day comparison is the starch-clay wash coat used by some mills as a means of correcting two sidedness. When attempts were made to apply higher solids coating mixtures, the results were quite often discouraging because the high viscosity of such a mixture caused patterning.

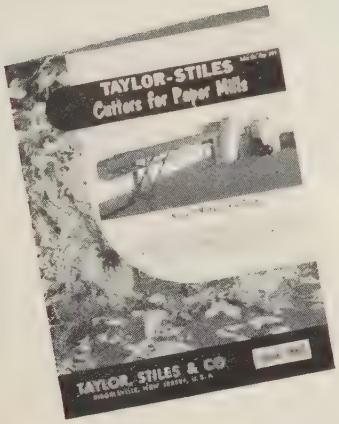
When latex is added to the starch and clay combination, higher solids coating mixtures are possible having lower viscosities and which flow and level better than straight starch coatings. Using these higher solids coating mixtures, coating weights in the 3 to 5-lb. per side range have been applied at a number of mill trials using a coating mixture that is in the same price range per pound as sulphite fiber or regular starch sizing.

Latex size press coatings containing 17½ parts of latex, 17½ parts of starch, and 100 parts of clay have been applied at the size press with a solids content as high as 45% solids, but the average solids range of our machine trials have been between 35 and 40%. The major factor controlling the amount of coating deposited on the sheet is, of course, the per cent solids with the type of furnish, degree of internal sizing, viscosity of coating mixture, and temperature having a lesser influence.

The application of the coating mixture at the size press is not difficult or tricky and does not require any modification of the size press or special size press rolls. We have applied these coatings on presses having all rubber rolls or combinations of brass and rubber or chrome and rubber, and at machine speeds ranging from 250 to 750 f.p.m. without slippage of the upper press roll.

One of the advantages gained from size press coating is a filled paper surface which has greater density and smoothness, resulting in a more uniform printing surface. As a result of putting latex into the coating, the paper has improved wet rub resistance, flexibility, smoothness, dimensional stability, and freedom from curl. These properties are not only ad-

Edward J. Heiser, Dow Chemical Co. Midland, Mich.



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TAYLOR, STILES & CO. 48 BRIDGE STREET RIEGELSVILLE, N. J.

vantageous for offset printing but for letterpress printing and off-machine coating as well.

The superiority of size press coated paper for letterpress printing does not need much explanation except that a cleaner, sharper, and more uniform printing impression on a brighter and more contrasting background is possible. This is especially true in halftone printing because the pigments generally used in a size press coating are smaller than the halftone dot and will reproduce halftones more faithfully than the comparatively larger wood fiber of the uncoated paper.

Size press coating provides an excellent base paper for top quality off-machine coating. The smooth, coated surface reduces penetration and uneven adhesive drainage into the sheet. This results in a smoother, more uniform top coat that has uniform ink receptivity. Perhaps the biggest advantage gained from the use of size press coated raw stock in conversion coating is that it provides the conversion coater with a means of producing a double coated sheet. I think most printers will agree that a double coated paper has a better printing surface than one with a single coating.

The recovery of broke coated with Dow Latex 512-K/starch and clay has not presented a problem. There is no reason to expect any trouble with it because the latex particles are thoroughly interspersed with starch and clay particles which are readily dispersible during repulping, and which prevent the formation of rubbery agglomerates. A great many mills have been using latex in machine and off-machine coating for many years now and there has yet to be a case of the formation of rubbery particles which can be traced directly to the presence of latex in a pigmented coating as long as the latex is not more than 65% of the total adhesive. Even then, the problem is not one of rubbery agglomerates but of inability to break down the coating due to the water resistance of the coating containing large quantities of latex.

To summarize briefly, coated paper containing latex, whether it is machine, off-machine, or size press coated, should give excellent printing results with regular inks and standard presses. The primary requirements of a sheet of printing paper are that it accept the ink uniformly, and that it have a smooth surface and dimensional stability. Latex will aid all of these properties substantially. It will also make a nondusting folding enamel possible and provide flat, noncurled papers for both letterpress and label paper with increased gloss ink and varnish holdout. Latex will also improve the flexibility and water resistance of both starch and casein binders.

The following is an abstract of the talk on "Chloroprene Latices for Paper" given by J. S. Hickman.

A brief history of the use of elastomer latices in paper was presented. This covered three fields: saturation, beater addition, and continuous addition. The properties of neoprene latex which have resulted in its use in these applications were summarized followed by a brief description of the methods of addition of neoprene latex to an actual paper machine. The properties of paper which has been treated with neoprene (for example, high wet strength, impact resistance, abrasion resistance, flexibility, internal and edge tear, and internal bond) were discussed. Samples of such papers which appear to have important commercial applications were shown. These included a large range of wet strength papers, filter papers, linoleum backing, imitation leathers, carbonizing tissues, twisting papers, and experimental glass fiber sheets.

W. R. Willets, *Recorder*

Meeting of Dec. 9, 1952

The Metropolitan District of the Empire State Section held its monthly meeting on December 9 at Fraunces Tavern, New York, N. Y. Seventy-nine members and guests attended. Herman Mark, noted authority on high-polymer chemistry, gave a most interesting discussion of the application of two new techniques to the analysis of cellulose fibers. He illustrated his talk with some excellent slides.

He described applications of ultraviolet and infrared spectroscopy to specific localities in the cell wall. These studies have shown that the lignin in wood is located principally at the outside and between the individual cells. It was also shown that cellulose in the outer wall of wood cells contains more carboxy groups than the cellulose toward the center of the fiber.

The electron microscope has shown that the outer wall of the fiber is actually a fabriclike structure made of cellulose fibrils, each 80 to 100 A in diameter. The inner wall of the fiber apparently consists of cellulose fibrils in more or less random order. Based on these observations, Mr. Mark likens the cellulose fiber to a silk stocking stuffed with balls of cotton.

He feels that the pulp refining process consists of shredding the fabriclike outer wall so that the loose strands of the inner wall are allowed to protrude and unite with fibrils from other fibers to form a sheet of paper.

In Mr. Mark's opinion, the application of these two new techniques, electron microscopy and ultraviolet-infrared analysis, to wood and paper technology has barely started. As research progresses it is the responsibility of every paper technologist to seek ways of applying the results to the improvement of papermaking.

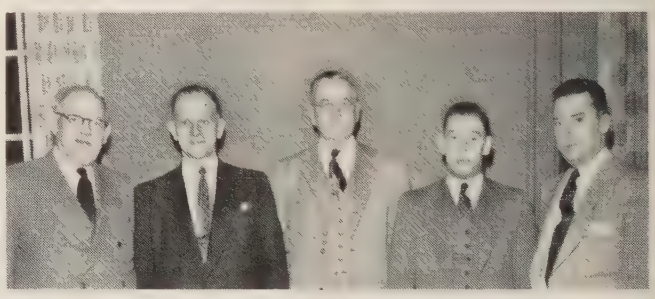
P. L. Haggerty, Chairman, presided at the meeting and C. G. Landes, Program Chairman, introduced the speaker. L. R. Ayers announced that the next meeting, January 13, will present a panel of speakers on various aspects of paperboard manufacture and use.

John Doherty, *Recorder*

Empire State

Central District

The December 5 meeting of the Central District was held at the University Club, Syracuse, N. Y. Harry Gray, Vice-Chairman, presided over the meeting attended by 96 people. A membership committee was appointed by Mr. Gray of the following: William Hall (Chairman), Harold Simons, and Ives Gehring. Mr. Gray introduced A. G. Durgin, General Superintendent of the St. Lawrence Corp., E. Angus, Quebec. Mr. Durgin spoke of his pleasant past association with Professor C. E. Libby. Mr. Gehring introduced C. Earl Osterheldt, retiring representative of the Du Pont Pigments Dept., who directed his remarks to the young men in the audience starting their careers in the pulp and paper industry. Leslie Morgan, Board Mill Superintendent, St. Lawrence Corp., was also introduced.



A. G. Durgin, St. Lawrence Corp.; Gus Holm, Sec. of N. Y.–Canadian Superintendents' Assn.; G. Earl Osterheldt, Du Pont Pigments Dept.; Leslie Morgan, St. Lawrence Corp.; and Ives Gehring, Oswego Falls Corp.

Harold A. Simons, Vice-President of Sweet Bros. Paper Co., Inc., Phoenix, N. Y., introduced H. D. (Doc) Cook of the same company, who talked on "Beating—an Old Angle."

The discussion, which followed, centered on the practical aspects of the Beatapulper (manufactured by Dilts Division of Black-Clawson–Shartle-Dilts, Fulton, N. Y., on license from the Cowles Co.) instead of the theoretical considerations of beating with which the talk dealt.

Mr. Cook disclosed that his mill retained the two Morden Stockmakers and two jordahs for each paper machine. Since the Beatapulper's capacity is only 20 tons per day, the Stockmakers are required for additional work on the fibers in order to maintain the production rate with tougher fiber furnishes. The stock refining could be carried to completion in the Beatapulper but it is felt desirable to leave some control of the stock quality to the machine tenders. The Beatapulper can be used for disintegrating as well as refining and lowering of freeness. There is a temperature rise associated with the refining similar to a Hollander beater.

Richard W. Sweet, H. D. (Doc) Cook, Robert Worrell, Harold A. Simons, Albert F. Caines, Alfred Corman, and Burton W. Sweet. All from Sweet Bros. Paper Co., Inc., Phoenix, N. Y.

It is Mr. Cook's intention to replace the bedplate and blades which have been worn by constant use for over a year. The bedplate will be 15° pie-shaped segments of Stellite Alloy B with ground surfaces fastened into a cast ductile iron backing ring. The blades will be forged chrome steel with edges faced with Stellite. It is estimated that these surfaces should last three to four times the life of the present tackle.

The top edge of the ring has worn slightly faster than the lower edge due perhaps to careless operation of the pulper while partially filled. The refining operation was not affected since the bedplate is aligned through three hydraulic cylinders. The refining rate has increased slightly as the bars became worn and sharp.

Left to right at the head table: R. G. Hitchings and S. E. Church, College of Forestry; H. D. Cook, Sweet Bros. Paper Co.; Harold A. Simons; Harry M. Gray, Oswego Falls Corp.; G. E. Osterheldt, E. I. du Pont de Nemours & Co., Inc.; Ives Gehring, Oswego Falls Corp.; E. C. Jahn, College of Forestry, State University of New York; and A. G. Durgin, St. Lawrence Corp.

It was pointed out that machinery manufacturers had long ago turned from multipurpose beaters to specialized stock treatment systems incorporating separate elements for circulating, disintegrating, refining, and mixing. Mr. Cook felt that the Beatapulper's use was justified from the standpoint of faster production rate and savings of labor and maintenance.

S. Earll Church, *Secretary*

Beating—an Old Angle

H. D. Cook

The title of this discourse is a pun as will develop later. I am not given to committing puns and so offer this advance confession in the hope of absolution. Beating has depended on angles since the first Hollander beater was used. Before we get involved with such modern equipment, however, let us consider the basic problem.

Paper was, of course, made for thousands of years from textile fibers. During the last hundred years short, wood fibers have taken the place of rag and plant fibers, except in the case of a very few, very low tonnage grades. Much of the skill, art, know-how, and tradition developed by so many years of operation when trades were respected and paid a great deal more than labor, are still with us, and much that is still with us is still good, but must be practiced with intelligence in consideration of the great differences between our wood fibers and the plant fibers of our fathers. In order to visualize these differences I have as Fig. 1 some fiber models to the scale of 1 in. equals 1 mm. or about 25.4 to 1.

This 40-in. wand represents the length of a cotton, linen, or hemp fiber, the fibers obtained from "rags" or other wastes. The 4-in. stick represents a spruce fiber, and the 1-m. chip represents a fiber of soda pulp from poplar or any broad leafed tree. The diameters of these models are not to the same scale. If they were only 0.012 in., which would be about right, you could not see them very well at this distance. They are so nearly the same compared to the differences in length anyway that it is not really important at this stage. If that bothers you, however, I have a piece of wire here that is 40 in. long and about 0.012 in. in diameter that more truly represents a raw cotton fiber to this scale in both dimensions.

Now, you papermakers, knowing the difficulty that you have in forming a sheet of paper out of a long spruce fiber which has not been beaten enough, can visualize the greater amount of work necessary to reduce the cotton fiber to good papermaking condition. You will agree, I think, that it will have to be reduced in length to less than the raw spruce fiber, quite a job of work in itself, but that is not all. It must be made more flexible, by pounding (beating). It must be shredded to some extent so that the fine flexible splinters (fibrillae) will intertwine and interlock so that they become stiffened by drying they will hold the fibers firmly together to make strong paper. Sometimes it appears that the fibers have been partially skinned and the filmy pieces or "skins" interfolded to lock the fibers together when stiffened by drying.

This work was first, and for thousands of years, done by hand by pounding (beating) the fibers or "halfstuff" with sticks on a stone or in a mortar with a pestle. These blows, so laboriously inflicted on the fibers, made them flexible as hammer blows would make an ashen wand flexible (40-in. wand). They broke the fibers up and the broken ends were broomed into splinters (fibrillae), as this piece of ash would be if dealt a blow severe enough to break it. Those of you who have examined beaten fibers under the microscope will be struck by this analogy.

During the early days of the mechanical age when man power began to be replaced by horsepower, the stamp mill was invented. This was a crude mechanical contrivance for lifting pestles and dropping them onto stock, or ore, in mortars. This was followed by the invention of the Hollander beater and the Kollargange. Let's by-pass the Kollargange which is only of historical interest, though I have visited two mills where they are still in use.

The Hollander beater is definitely still in use and is diagrammed in Fig. 2.

Note that the roll, fringed by fly bars, is a paddle wheel which lifts the stock over the backfall and causes it to circu-

H. D. Cook, Sweet Bros. Paper Co., Inc., Phoenix, N. Y.

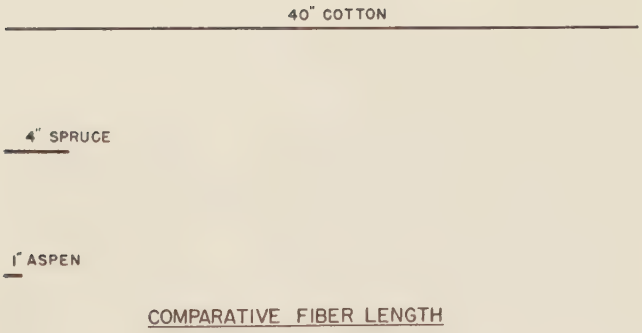


Fig. 1

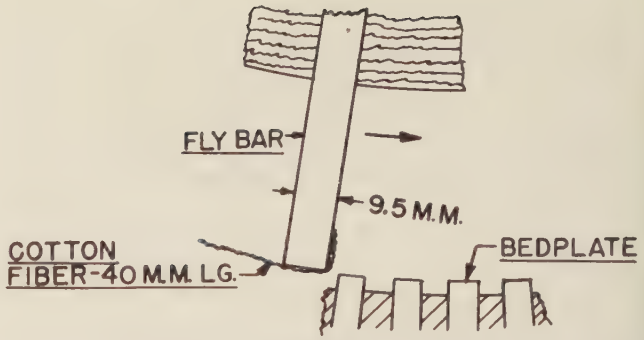


Fig. 3

late around the tub and midfeather. Let us by-pass the circulation problem since its purpose is merely to return the fibers to another opportunity to be affected by the flybars on the roll as they pass over the opposing knives of the bed plate. Though this type of equipment is being gradually replaced by newer designs, notably refiners, the basic action is very similar or remains nearly the same when you reduce your perspective to fiber size, so let us attempt to analyze it.

Figure 4 diagrams a $^3/_8$-in. beater bar with a full length cotton fiber "stapled" over its leading edge.

As the flybar moves through, the stock fibers which lie at an angle with its leading edge are bent around it and held against it by the eddy currents of water which it disturbs in its passage as well as by the inertia of the fiber itself. This is called "stapling." The fiber is carried in this position until the flybar passes over the bed plate bars. If the roll is set low enough, the fiber is sheared, bruised, or even cut in two as the opposing knives pass each other.

Figure 3 is, of course idealized. Long fibers actually pile up on top of each other as they staple around the leading angle of a flybar. The longer they are the thicker they pile up. This fact was once used as a measure of the degree of beating or length of fiber. When a sharp-edged knife is passed by hand through a beater tub of stock, fibers collect on the edge. As the fibers are reduced in length by beating, less can be collected on the knife edge. If these fibers are dried and weighed, a numerical measure of fiber length or degree of beating is obtained. This was once used as a control method or test.

Figure 4 attempts to diagram more realistically the actual collection of fiber (raw cotton) around the leading angle of $^3/_8$-in. flybar.

Note that there is considerable clearance between the flybars and bed plate. This is made necessary by the thick bunch of stock that is being carried. The full weight of the roll can be supported by this stock. As the fibers are shortened, however, less collects on the leading angle and the roll has to be lowered to decrease the clearance between bars and plate in order to obtain action on the fibers. This adjustment of the beater roll once demanded the greatest skill and attention of the beater engineer, and still does where fine paper is made from long, tough fibers. Since this lowering of the beater roll has been known to be a mysterious skill of a careful beater engineer for generations, it has become ritual. It is still useful where it applies, but it can be meaningless if applied without understanding. Let us consider the relative condition if this same beater is furnished with raw sulphite fiber, or when the raw cotton is reduced to the length of raw sulphite as shown on Fig. 5.

You will note that this short fiber makes a very small bunch around the bar edge, and that the clearance between bar and plate is so small that the roll can be lowered very little before steel-to-steel contact is made. Nevertheless, if the fiber is good and tough it will bear the full weight of the roll, but not for long. It is dangerous to apply the full weight of the roll because play in bearings and spring of supporting tackle may reduce the clearance to zero as the support of fibers decreases as they shorten. If steel-to-steel contact is allowed the stock is spoiled by what the papermaker calls "steeling." This is evidenced by the smell of burning steel about the beater. What happens to the stock to make it useless is something that I do not understand, but I know from bitter experience that it will not form an acceptable sheet of paper. The fibers seem to stand on end and will not couch properly.

There is another thought that forces itself on me now. Here we have a $^3/_8$-in. flybar that is only half covered by fiber. Then what good is the other half of the bar? A fiber to be affected must be stapled over the edge of the bar. This statement is generally accepted as fact by all who have observed with intelligence and written after due consideration of the engineering probabilities. If it were not so, the bar would have to be less than the diameter of a fiber from the plate to affect the fiber, and then not more than 5% of the area between bar and plate would be occupied by fiber in a consistency of 5%.

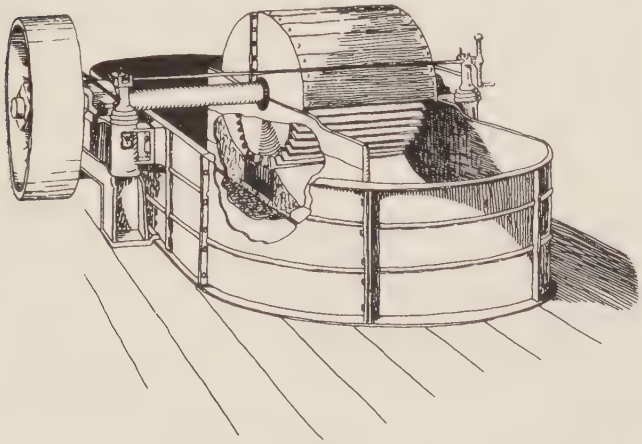


Fig. 2

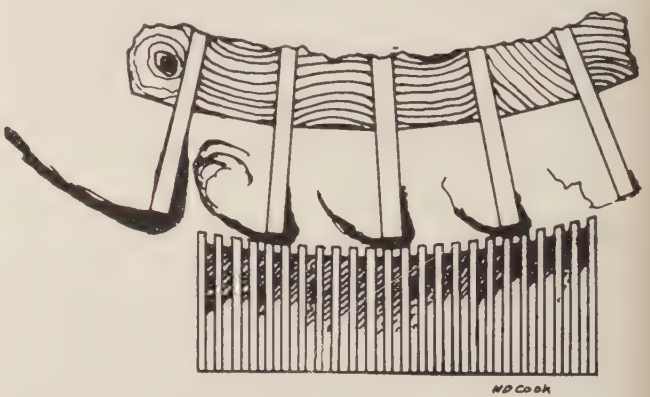


Fig. 4

Fig. 5

The specific gravity of commercial wood pulps according to Sutermeister is 1.41 to 1.63. If I use the value of 1 for the sake of simplicity, I am yielding some advantage of argument as you will see, but I can afford to do so. If a fiber weighs as much as its volume in water, then in a 5% suspension of fiber in water only 5% of the total volume is fiber. In a perfectly dispersed suspension of fiber, if two surfaces approach each other, water will be forced from between them carrying its fixed percentage of fiber with it. As the surfaces approach fiber diameter some fibers may be entangled so that in some spots two or three diameters are interposed, but if dispersion is perfect, or nearly so, this should be a small portion of the total fiber left between plates when they are 1 fiber diameter 0.012 in. apart. Spots where fibers are caught one on top of the other should be offset by spaces where fiber is lacking. Then if fiber occupies only 5% of the volume and the surfaces are only a fiber diameter apart, then only 5% of the opposing surfaces may be in contact with fiber.

This argument may not be 100% sound, but it is sound enough to convince me that fibers must be collected and held until they are caught between the acting surfaces in order for any important proportion of them to be affected by contact. I cannot imagine any other way of concentrating and holding these fibers than on the sharp leading edge of one of the surfaces—stapling. The only accuracy needed is one of "order of magnitude."

If we accept the statement as fact, the fiber must be stapled, then we cannot expect the width of the bar to be covered much beyond half of a fiber length. Then what price broad bars which are generally considered necessary for producing

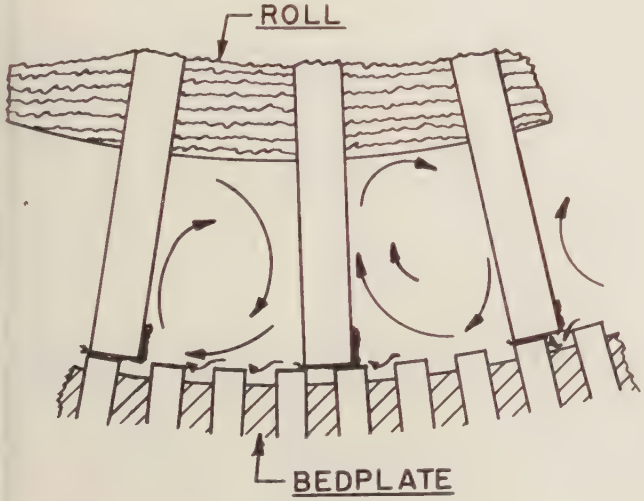


Fig. 6

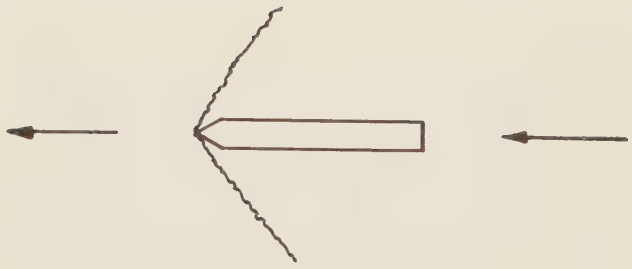


Fig. 7

"hydration" versus "cutting." I am tempted to develop this argument because it is a favorite topic of mine, but it would take time that I cannot afford here if I am ever going to come to the point before you tire.

It is difficult for some of you to believe that fiber will staple over the square edge of a flybar as it passes through stock in the manner that it does. I can remember seeing proof that it has to. This proof was based on principles of hydraulics and developed by complicated mathematical treatment. I do not remember the process, nor can I now generate it, but my abstract reasoning and practical observation make me sure of it. There are enough others of the same mind in this audience, so I do not feel uncomfortable when I assert it.

Here I offer Fig. 6 in an effort to overcome your skepticism on this very important point.

This is the first figure that has not maintained the scale of 25.4 to 1. It attempts to show the motion of stock between the flybars as it must be as the bars pass over the plate. The stock and water, trapped between the bars, must be rolled in this manner as it is dragged across the interrupted surface of the plate as indicated here. You will note that the currents split over the leading angle of the bar and would tend to hold a fiber bent over this angle by friction or drag on each end of the fiber. They would pull on each end of the fiber bent over the sharp leading edge of the bar. Your first conception is that the current must be centrifugal and carry the fiber away from the angle, at least down to the plate. I do not concede this point but, if I do so, for the sake of argument, you must concede that there cannot be such motion over the plate because there is no place for the stock to go. It is trapped. The greatest pressure component may be centrifugal but it cannot cause centrifugal motion because the pocket is sealed.

You will also note that each bed plate bar is separated from its neighbor by a wooden spacer, and that the spacer is lower than the top of the bar in a properly maintained plate. This leaves a small pocket between each plate bar. The purpose of this is to let a little stock out from between the flybars as it passes over them so that fibers may be stapled over the edge of the bar, flybar, or bed plate bar. Whether this design is the result of consideration such as this or not I cannot say. So much of the technology of our old industry is the result of trial and error that it is hard to say. But if we can understand the basic, physical reason for a successful empirical result we can apply it more intelligently. There is profit

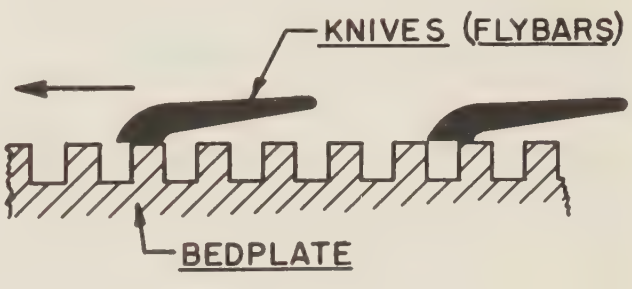


Fig. 8

in trying to analyze the reasons for an achievement by an artisan who may not be able to explain, himself, why his method works. You do not have to be wholly original to be useful. Neither do you have to rob the artisan of credit for his contribution. This, you may easily do, because of your superior power to transmit ideas, but if you do—shame on you.

Now, let us get back to stapling and the skeptics. It is easy for you to imagine a flexible fiber stapling over a knife edge if the knife strikes it at an angle with its length. I can strike a cotton string with a wand, and you can see it before your very eyes.

As the angle of the knife edge grows larger your skepticism grows with it, and when it reaches 90° as on a flybar you give me trouble. You have probably never seen a flybar with an angle less than 90° but I have, and I want to tell you about it even though I must mention a patented product of a manufacturer and thereby lay myself open to the accusation of advertising before this organization, which has been one of my pet gripes. Our programs should not be so used. This equipment is novel and, I believe, will be a definite contribution to our technology. I have had the privilege of using the first mill installation, and I am going to talk about it briefly. I will be glad to show it to you if you will visit us.

The working elements of this Betapulper are diagrammed in Fig. 8.

In the Betapulper the knives (flybars) pass over the stationary plate as shown. The plate is held against the knives by hydraulic or pneumatic pressure of any regulated amount desired or demanded of the stock. As the bunch of stapled fiber becomes thinner, due to reduction in length, the clearance between bars (knives) and plate becomes automatically less as constant regulated pressure is maintained by the hydraulic control. The argument here presented is provoked by my effort to rationalize the efficiency and peculiar beating characteristics of this equipment.

I have had neither time nor facilities to establish the abilities of this equipment on a technical basis, but it has been carefully done, and I will leave the report to the investigators. I may say that the results have been the basis of critical decisions—and commitments of large capital.

On the basis of my practical use, confirmed by inspection of laboratory tests, I believe it to be unusually efficient in use of power to develop strengths from pulp. It will develop a burst test with less reduction of tear test than any other equipment that I have used.

Inspection of pulp prepared by this Betapulper shows more "fibrillation" in relation to cutting or shortening than I have seen produced by any other equipment.

The same stock jordaned has a larger proportion of cut or broken fibers. I attribute this difference to the superior stapling ability of the small angle of the leading edge of the knife (bar), the greater number of blows (beats) per minute, and the ability to carry a light but positive pressure of the knife on the plate. It is like a brushing action in a beater, but the brushing action is so concentrated that you can safely accomplish results that would take more hours and more horsepower-hours in a conventional beater.

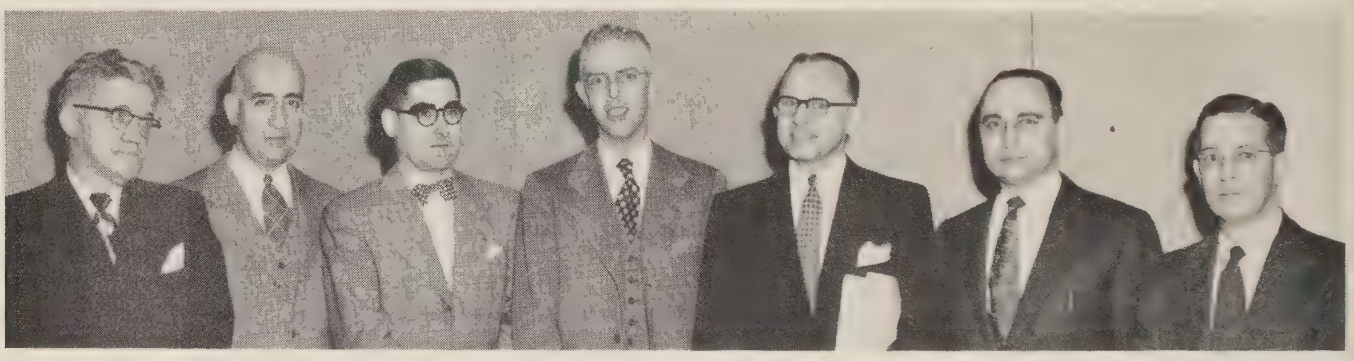
I have taken all of your time that I dare to take, and will now sign off with the hope that I have contributed something to your thoughts on beating.

If you have any questions or rebuttals, I will be glad to try to answer them.

The statements made here are based upon my own experience which is not all inclusive and my reasoning which may be lame, but they are the best that I have. I know that several of the statements made are controversial, and I have taken a definite stand on one side of the controversies. This should provoke discussion. If any of you care to raise your voice in indignation and set me straight, I am sure that there is time for it.

Empire State (Northern District)

Seventy-five members and guests of the Northern District of the Empire State Section, on Dec. 11, 1952, heard John H. McGovern of the Forest Products Laboratory, Madison, Wis., discuss the utilization of hardwoods in the pulp and paper industry. In his talk Mr. McGovern compared the development of the use of hardwoods to the development of the crystal radio set of many years ago into the television sets of today. He said it is felt by some that the hardwoods represent the last frontier of pulpwoods. Mr. McGovern stated that hardwoods will have their greatest utilization in the sulphate, semichemical and chemigroundwood processes. Except for very high-strength papers such as those used in heavy duty multiwall paper bags and in newsprint the paper made from hardwood pulp is being used for most all of the end uses of paper. Mr. McGovern illustrated his talk with slides which showed the rapid increase in the use of hardwoods from 1930 to 1951 with a forecast to 1960. During a question-and-answer session Mr. McGovern answered that the pollution potential from the semichemical process is not any greater—possibly less—than the sulphite process. He also stated that the chemical debarking of hardwoods shows signs of being effective.



H. A. Spencer, Knowlton Brothers, Inc.; R. M. Drummond, International Paper Co.; R. J. Murtaugh, St. Regis Paper Co.; J. H. Treadwell, Treadwell Supply Co.; J. N. McGovern, Forest Products Laboratory; R. A. Premo, Gould Paper Co.; and J. D. Parmele, St. Regis Paper Co.

Robert Drummond, chairman of the Empire State Section, spoke of the necessity for membership in the Section and in national TAPPI and the active participation of the membership in the work of the Section.

Richard A. Premo, chairman of the Northern District, presided at the meeting and introduced the guests.

RICHARD J. MURTAUGH, *Secretary*

The Preparation, Handling, and Transportation of Pulpwood East of the Rockies

J. A. HOLEKAMP

Because there are so great a number of subjects and such a variety of methods I can only hope to touch on the high lights of this field of activities commonly known as the pulpwood industry, within the time alloted for presentation. The handling of pulpwood represents a very large percentage of the total cost per cord of pulpwood delivered to the mill. Consequently, this subject of material handling and its application represents my foremost activities as logging engineer for the American Pulpwood Association.

The fact that the pulpwood industry consumed over 24 million cords, or 50 million tons of pulpwood, in the year 1951 and has handled each cord of wood from two to twelve times, is indicative of the over-all scope and size of the many material-handling endeavors carried on by this industry. Keep in mind, during the year 1951, 50 million tons of pulpwood were

Fig. 1. Loading drays with a hydraulic loading attachment mounted on the skidding tractor
(*The Vercillino-Ware Pulpwood Loader, Vercillino Bros., Gwinn, Michigan*)

cut; skidded; hauled; loaded onto railroad cars, barges, or trucks; driven down streams, rehandled two or three times at the mill—all before being placed on the woodyard conveyor to the woodroom for further processing into a raw material substance which could be utilized by the pulp and paper industry. Is there any wonder why so much of my time, in fulfilling the requisites of my job, is devoted to the subject of material handling?

In spite of the tremendous tonnage of raw material which must be handled every year, material handling methods requiring manual labor are those most used by the pulpwood industry today. In touching on a partial explanation for the material handling methods adopted by this industry, and to further qualify the still present practice of handling great quantities of this product by hand labor, four of the more important factors affecting the production of pulpwood should be understood.

Pulpwood is heavy and must be handled by hand on a stick-by-stick basis or in economical sized units by relative large and expensive pieces of equipment. Green southern pine, for example, weighs over 5000 lb. per 128 cu. ft. rough cord, or can range from 40 to 100 lb. per average sized stick. Thus pulpwood is a raw material which is often too heavy to handle by hand, on a stick-by-stick basis, and too light to justify use of mechanical equipment.

J. A. Holekamp, Logging Engineer, American Pulpwood Association, New York, N. Y.

Fig. 2. Dixie pallet system—bobtail truck
(*Tidewater Equipment Co., Brunswick, Ga.*)

Pulpwood is an awkward material to handle. By its very nature pulpwood usually requires at least one manual handling before grouping into payload bundles by mechanical equipment is possible. Pulpwood bolts must be placed in a pile, either by the cutter or some other designated individual, before any effective material handling method requiring economical payload units can be employed.

The supply of pulpwood is furnished by multitudes of small independent producers. The idea that mechanical handling equipment is often expensive arises from the fact that low profit, risk, and interest return margin per cord of wood will seldom permit use of mechanical equipment unless large volumes of pulpwood are to be handled. Keep in mind that 84% of all the pulpwood produced in this country during the year 1950 was accomplished by small independent pulpwood producers, many not producing more than 800 to 1000 cords per year.

The adoption of new material handling ideas and methods are often retarded by a conservative attitude toward a changing situation: By a changing situation, I mean the shortage and high cost of labor, a reduced productive capacity per individual woodsmen when using nonmechanized equipment, the necessary logging of terrain which previously was passed over in preference to more choice tracts of timber, and a demand for pulpwood today in quantities exceeding any previous record.

In realization that certain phases in the production of pulpwood will usually require some manhandling, this industry, at the present, is concentrating its efforts on mechanizing those phases in the cycle of pulpwood production which promise the greatest financial savings and increase in production. Please don't misunderstand my thoughts. Providing certain con-

Fig. 3. Dixie pallet truck and trailer unit
(*Tidewater Equipment Co., Brunswick, Ga.*)

Fig. 4. Pettibone-Mulliken Cary-Lift equipment with fork and arm clamp
(Pettibone-Mulliken Corp., Chicago, Ill.)

ditions exist, members of the pulpwood industry are quite conscious of the fact that animal and manhandling can produce cheap pulpwood and in large quantities. However, with the passing of every year, every month, this industry has pulpwood producing regions that are rapidly approaching or have approached a situation such as this: we have the horse but not the man. We have the man, but not the horse. Or, we have both, but no large tracts of timber. The "good old days" to which the oldtimers refer shall never return, for by that time the pulpwood industry will have experienced such a taste of mechanization that many of the very efficient methods employed when use of animal and manual handling was at its peak, will be forgotten or the complete combination of men, equipment, and timber will be nonexistent.

GENERALIZED PICTURE OF PULPWOOD PRODUCTION

The pulpwood industry, as known to me, consists of five pulpwood producing regions, all with conditions and specific characteristics differing from the other.

1. The Lakes States region is characterized by a shortage of labor, is highly mechanized, and the 8-ft. pulpwood cut in this region is handled very well by mechanical equipment.

2. The Northeast region where imported Canadian woodsmen have assured an ample labor supply in the past; material handling methods are not highly mechanized; and wood is cut in 4-ft. lengths which is difficult to handle mechanically.

Fig. 5. The P-M Cary-Lift equipped with clam-shell grapple which can be revolved 360°
(Pettibone-Mulliken Corp., Chicago, Ill.)

Fig. 6. A Schield-Bantam crane loading 4-ft. hardwood in Maine
(Schield-Bantam, Waverly, Iowa)

3. The Appalachian region, with much use of hand labor; material handling methods are not mechanized; and wood is cut in 5-ft. lengths which can be handled effectively with slings. No further reference will be made to this region in this paper for methods seem to be a combination of those employed in the South, Northeast, and the Lakes States.

4. and 5. The Southeast and Southwest regions where labor is in good supply with signs of shortage in some areas; industry members very mechanically conscious; and wood is cut in 5-ft. lengths which permits effective handling with slings.

CUTTING OPERATION

The felling, bucking, and limbing of pulpwood is usually performed by a single woodsworker using an axe and some type of power or hand saw. In the Lake States and the Northeast a one-man chain saw has become quite popular while the wheel-mounted circular saw and the two-man chain saw are favored in the South.

Wood is either cut "tree length" or bucked into short bolts at the stump—"stump-cut" wood. In the South, most "stump-cut" wood is loaded directly onto trucks without prior piling, while operators in the Lake States and Northeast regions require the cutters to pile this wood next to a skid trail for piecework payment and transport at a future date. "Tree length" wood is neither bucked nor piled at the stump.

SKIDDING OPERATION

On operations where wood is cut and piled, mechanical material handling methods become practical. A large per-

Fig. 7. Loading tree length hardwood pulpwood in the Northeast

Fig. 8. A simple overhead jammer for unloading trucks in Michigan

centage of the piled wood in the Lake States and Northeast regions is loaded in the winter by hand onto drays or sleighs which are pulled by horses or tractors either to a river dump to a road for loading onto trucks or larger sleighs. Michigan operators, employing a small crawler tractor-loader equipped with a hydraulically operated set of jaws, can mechanically load wood from pile to dray, furnish the motive power to bring wood to a road, and transfer the load onto some types of trucks (Fig. 1). In the more mountainous areas of this Lake States region, tractors with sulkies successfully skid piles of 8-ft. pulpwood, contained by lock-type chockers. This permits the mechanical transfer of economical sized bundles onto trucks with a simple jammer.

Known as "yarded" wood in the Northeast, "tree length" wood is skidded by single horses or small tractors to a truck road or to high ground before being bucked into short lengths and piled for future forwarding or transport. "Tree length" wood in the South is bucked and loaded into iron pipe pallets at some point adjacent to a truck road or is loaded directly onto trucks by hand. Long lengths of pulpwood are often skidded in all regions with tractors and sulkies to a portable slasher saw where reduction into short lengths is accomplished. Several large operators truck these long lengths to the mill where multiple slashers perform the job of bucking.

LOADING TRUCKS

In regions where the supply of labor is good and pulpwood size does not require mechanical handling equipment, man-

Fig. 9. A hydro-crane unloading a truck in Michigan
(Bucyrus-Erie Co., S. Milwaukee, Wis.)

Fig. 10. Loading rack cars in South Carolina with crawler crane and slings

handling is the principal method employed to load trucks or sleighs.

In mechanizing, the South favors the winching of loaded steel pallets onto a truck frame assembly with power supplied by a small winch mounted behind the truck cab. With pallets preloaded, five men equipped with a D-2 tractor, four pallets, a pair of iron detachable slides so pallets may be drawn about the woods, one circular wheel mounted saw, and a 3-cord capacity truck equipped to handle these pallets—can deliver 3 cords per man day from stump to the mill when working a 10-hr. day and hauling 30 miles one way (Figs. 2 and 3). This figure is to be compared with a recent survey in the South which indicated a production average of 1 cord per man day. In Louisiana one operator procures farmer-cut wood by dispatching 34 detachable truck frames or pallets of $4^1/_2$-cord capacity which can be winched preloaded onto a truck for delivery to the mill. With mechanical means of unloading at the mill, a pallet system permits a small operator to produce efficiently by keeping his hauling unit on the road with loading and unloading time reduced to a minimum.

Small producers in the Lake States make use of a boom and hoist loader mounted on the truck which enables the handling of wood singly or in small bunches. Larger operations employ semimobile gravity swing-boom jammers which can transfer $1^1/_4$-cord loads from drays to trucks. Wood piled adjacent to truck roads is loaded onto trucks with a Drott-skid-loader or a $^1/_2$-yd. crawler crane equipped with a $^1/_2$-cord capacity clamshell grapple. The Drott-skid-loader is a tractor-mounted loader equipped with jaws so a $^3/_4$-cord load of 8-ft. pulpwood

Fig. 11. Transferring wood from storage to rack car at rail concentration yard in Alabama. Note special gooseneck boom
(Thew Shovel Co., Lorain, Ohio)

Fig. 12. Tournacrane handling pulpwood in South Carolina
(*R. G. LeTourneau Co., Peoria, Ill.*)

Fig. 14. Hyster Model 150 fork lift truck handling pulpwood at rail concentration yard in Alabama
(*Hyster Co., Peoria, Ill.*)

may be picked up, transported, and deposited on a truck. Production will average 115 cords per 9-hr. day on a 30-mile round trip haul with either crane or skid loader. Gaining popularity throughout the country, especially in the Lake States, the Pettibone-Mulliken Cary-Lift (Fig. 4) can perform most of the material handling endeavors claimed by the tractor-mounted loaders of the same type. With the advantage of mobility, reduced maintenance costs as compared with crawler units, and the feature of a special attachment whereby trucks and railroad cars can be loaded and unloaded from the side (Fig. 5), many operators express favor toward the use of this wheel-mounted loader. These three different machines eliminate cost of snow removal from piles and experience little difficulty when working from frozen piles of pulpwood.

In the Northeast portable conveyor loaders permitting the stick-by-stick loading of trucks have been in use for many years. Recently, the $^3/_8$-yd. capacity Schield-Bantam truck-mounted crane, equipped with a 1200-lb. clamshell grapple has been put to work—especially when handling heavy hardwood (Fig. 6). This machine can load coniferous pulpwood at a rate of 80 to 90 cords per 10-hr. day. One company is loading tree length hardwood pulpwood onto large diesel truck trailer units with $^3/_4$ yd. crawler cranes equipped with a 40-ft. boom and a set of heavy log tongs (Fig. 7).

UNLOADING TRUCKS AND TRANSFERRING WOOD TO RAILWAY CARS

Here again manhandling accounts for most of the wood handled at this phase of the production of pulpwood—especially in the South and the Northeast. This fact is often difficult to comprehend for pulpwood on the truck is available in units of volume which facilitate effective transferring and unloading by mechanical means. Simple divider stakes on the truck rack will permit a selection of any size bundle to assure that the capacity of a mechanical loader is not exceeded. In some regions the necessity of using large numbers of box cars in lieu of specially designed pulpwood rack cars accounts for a great deal of this manual transfer of wood from trucks to rail cars.

For a number of years operators in the Lake States region have been conscious of the savings to be realized by handling pulpwood in bulk at this point. This is shown by use of inexpensive jammers to transfer $2^1/_2$-cord loads of 8-ft. wood from trucks to railroad cars at a rate of 120 cords per 9-hr. day. Hoisting with one drum of the double drum winch, the second drum is used to locate the open-sided cars as loading progresses (Fig. 8). Many companies make use of cranes equipped with clamshell grapples to perform this task—especially if wood must be piled beside the spur track and loaded into cars at a future date (Fig. 9).

Within the last 10 months, companies in the South have constructed pulpwood concentration yards equipped with spur tracks and sufficient area to store large volumes of wood. Using a split sling with a toggle pin trip, $1^1/_2$ to $1^3/_4$-cord bundles are transferred from trucks to rack cars or to storage. Bundles placed in storage are contained with $^3/_4$ by 0.050-in. steel strapping for rehandling at a future date. The $^3/_4$-yd. crawler cranes (Fig. 10) operating at many yards cannot store wood outside of its 15 ft. operating radius from the car, while wheel-mounted cranes can transport wood any reasonable

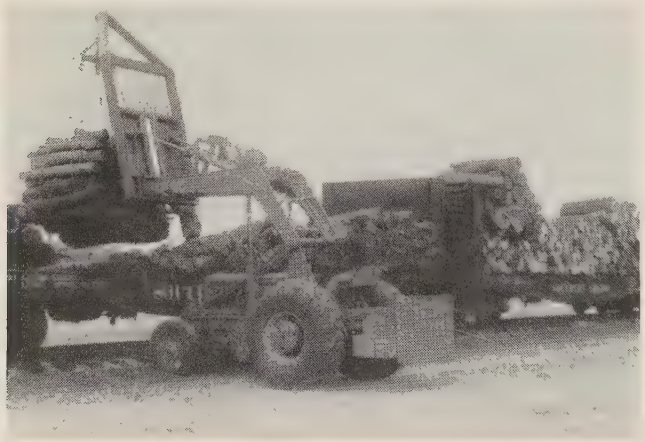


Fig. 13. The Harrison Loadercrane transferring wood from trucks to rack cars in South Carolina
(*Harrison Mfg. Co., Columbia, S. C.*)

Fig. 15. Dumping truckloads of wood into water storage in Maine

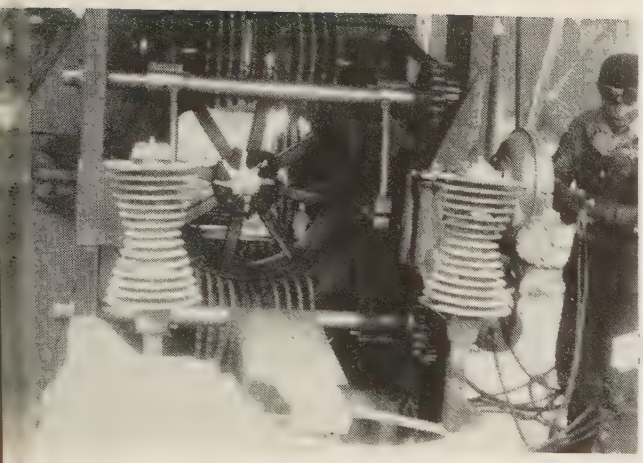


Fig. 16. The Anderson barker
(*Soderham Machine & Mfg. Co., Talladega, Ala.*)

istance from storage to rack car (Fig. 11). Tractor-mounted ...lers are competing with cranes to do a more effective job t a lower cost per cord (Figs. 12 and 13). From all indications fork lift trucks, which have proved very successful in ther lines of endeavor, will prove a good inexpensive loader fter necessary minor modifications have been made (Fig. 14). f the scheduling of truck arrivals is ideal, these machines can ad 220 cords per 9-hr. day.

Removing wood from water storage with a jackladder onveyor system, one big company in the Northeast dumps ood into special open top pulpwood cars at a rate of 72 cords er hr. These cars, of 16-cord capacity, are unloaded at the ill by securing each car to a hydraulic side dumping platform ripping the doorlike sides, and tilting the car so wood is spilled nto a storage pond. Trucks are unloaded in like fashion, except wood is dumped off the back (Fig. 15). Other companies n this same region are using $^3/_8$-yd. truck-mounted cranes quipped with $^1/_8$-cord capacity clamshell grapple to effect is transfer from truck to open top pulpwood cars. Thought as been given to the use of a single sling and a $^3/_4$-yd. crane to nload one tier at a time from trucks into a frozen river dump here the conserving of space is an important factor.

LONG DISTANCE TRANSPORTATION

A great quantity of pulpwood today is still shipped by rail box cars. Confronted with an expensive manual loading nd unloading charge, the industry is forced to use this type ar until replacements by pulpwood cars is completed. In ealization that this might be a long time into the future, and with many attempts to reduce loading and unloading charges by use of mechanical equipment, studies have been conducted to determine the relative merits of shipping pulpwood by box car in the form of chips. Testing in the Northeast indicated that a 40-ft. box car with a 2960-cu. ft. capacity scaled 12.33 cords when a conversion factor of 220 ft. per 128 cu. ft. peeled cord was used. This car could normally carry 19 cords of 4-ft. rough pulpwood. When blown into a box car, chips pack more tightly and a factor less than 220 cu. ft. is justified. Recent introduction of an effective mechanical log debarker has stimulated interest in the conversion of sawmill waste into chips (Figs. 16 and 17). With a recovery of 0.43 cord per 1000 bd. ft. lumber talley being experienced by large band sawmills in the South, more information concerning the cost of transportation and the cost of mechanically loading and unloading chips into these box cars should become available.

In the Lake States gondola cars and renovated flat cars haul an average of 20 cords of 8-ft. wood per car. With the exception of the special pulpwood car with doorlike sides for the dumping of wood, pulpwood cars in the Northeast are constructed with sides which will not permit mechanical unloading. These cars will hold from 16 to 25 cords of 4-ft. pulpwood.

The South has developed an all-steel open-sided rack car which will carry up to 26 cords of green 5-ft pulpwood. Because these cars can be mechanically loaded and unloaded they are being tested for possible use in the Northeast.

Fig. 17. The Anderson barker
(*Soderham Machine & Mfg. Co., Talladega, Ala.*)

Fig. 18. An Evans-Busch trailer crib in South Carolina
(*John Evans Mfg. Co., Inc., Sumpter, S. C.*)

Of interest is the large fleet of truck-trailer units employed by one company in the South to supplement a railroad system that is unable to supply the mill with a sufficient volume of pulpwood at the desired transportation cost. Complete with dispatcher and radio communication, each unit is designed so an empty trailer crib can be placed on its own legs while the rear wheels and bogie are removed for placement beneath a loaded crib. After the tractor has fastened onto the loaded trailer, the legs are retracted and the entire trucking unit is ready for a trip to the mill (Fig. 18).

CONCLUSION

In restricting the subject of material handling to the minimum number of required steps of piling, skidding, and loading and unloading trucks or sleighs, 32 to 38% of the total cost of production required to deposit a cord of pulpwood at an unloading point is absorbed by material handling. On operations requiring a number of pulpwood rehandlings and when all handlings are included up to the point of placing wood on a mill woodyard conveyor, this per cent of the total cost of production becomes quite large. In view of this fact, considera-

tion of improved material handling methods are of utmost interest and importance to the pulpwood industry. The growing shortage of manpower, the increased cost of labor, and the demand for quantities of pulpwood exceeding all previous records will necessitate the replacement of manpower with machine power in a number of operational steps required in the production of pulpwood.

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Instruments in the New Riegel Mill

C. E. ROTH, H. R. ARNOLD, and R. H. PEARSON

In keeping with the modern design and construction of Riegel's new mill, all sections are equipped with the very latest types of instrumentation. Some of the more interesting features of the instrumentation equipment are summarized below.

All instruments are conveniently and attractively grouped in cabinet type panel assemblies at various locations in the mill most suitable for easy observation by supervisors and operators.

The Foxboro digester liquor charging system, which is shown in Fig. 1, is fully automatic and adjustable with push button operation at the start of each cycle, thus providing flexibility in liquor make-up to meet varying demands, and uniformity and accuracy of digester loading to produce maximum uniformity of pulp.

The Foxboro digester cooking controls (Fig. 1) on Riegel's six digesters are of an improved type. They provide a continuous record of digester top temperature with an intermittent record of digester bottom temperature; both are recorded on the same chart with digester pressure. This arrangement furnishes the operators, the pulp mill superintendent, and the process control department with a simple and easily interpreted record of the most important measurements on one chart, from which it is possible to see at a glance whether digester circulation and relief are adequate. Steaming and relief are fully automatic for both kraft and semichemical operation. The digester steaming is controlled by the operation of temperature cams, the temperature being measured in the circulating liquor line, with consequent decrease in steam consumption and increased uniformity of pulp. The Foxboro relief controls introduce an improved feature for the measurement and control of relief gases. The relief control is a temperature difference controller including a pen for recording the relief valve position, a system which is providing excellent results with negligible liquor carry-over.

In the washer room the controls for each individual stage of the four-stage IMPCO vacuum washer are located at the vats on console type cabinet panels for ease and efficiency of operation. These are shown in Fig. 2. The main washer panel, shown in Fig. 3 includes a Foxboro multipoint level recorder which records the level of the liquor in the weak and intermediate black liquor tanks to the washer showers. A multipoint flow recorder records the flow controlled by each of the Consotrol controllers on each washer console. These console panels feature Foxboro Consotrol controllers for shower flow, and provide a central and effective location for push buttons and rheostats for motor control, and pneumatic loading on press rolls. The main washer panel is located at one end of the room and includes controllers for blow tank dilution, stock flow, foam tank level, hot and warm water temperatures, and consistency, as well as recorders and indicators which furnish valuable information for accounting and control purposes. The arrangement of instruments on a centrally located panel permits speedy inspection of the records with consequent time saving on adjustments necessary to maintain production at the highest possible level.

The fully enclosed, glass-paneled instrument control room shown in Fig. 4, located on the operating floor of Riegel's modern bleach plant, sets a high standard of cleanliness. The Foxboro instruments are protected from corrosion by a pressurized panel. Here again, centralization of instrumentation affects time savings which reflect higher production rates. Individual tower and washer controls are conveniently located on console-type cabinet panels, as shown in Fig. 5, on the operating floor outside the control room for maximum efficiency and convenience of operation and observation. In addition to the instrumentation for the IMPCO chlorination, caustic, and hypo stages, recorders and controllers are also provided for the final chlorine dioxide stage, including control of sulphur dioxide water by oxidation reduction potential measurement.

A separate control room is set aside from the chlorine dioxide plant to protect the instruments from corrosion and to provide suitable facilities for engineering and test work. Among the numerous control and recording instruments on the panels in this room is a flow controller for the ratio of methanol and air with special mechanism to preclude the possibility of mixtures above safe operating limits. The balance of the chemical plant instrumentation is located in a second control room close by and includes indicators, recorders, and controllers for sulphur burner operation and control of chlorine gas to the bleach mix tank by oxidation reduction potential measurement. All of the instruments in these control rooms are Foxboro.

Figure 6 shows the instrumentation in the pulp machine section which includes Fischer-Porter water flow and stock flow control to the pulp machine, and Foxboro level measurement in the stock chests, pneumatic loading on press rolls, steam pressure control to the drier. A Foxboro Dewcell controller controls the moisture in the Ross drier by controlling the input and exhaust air dampers.

The six-effect Goslin-Birmingham black liquor evaporator is equipped with fully automatic Foxboro controls to attain maximum evaporator efficiency and maximum uniformity of liquor gravity to the furnace. The key controller among these is the boiling point rise instrument, which resets the total thin liquor flow to the evaporators to maintain constant gravity output to thick liquor storage.

Instrumentation is very much in evidence in the screen room where complete flow and consistency control removes many of the variables for the operators to increase the efficiency of the screening process. A Foxboro flow controller

Fig. 1. Digester and liquor measuring controls with Bristol recording ammeters

C. E. Roth, H. R. Arnold, and R. H. Pearson, Riegel Carolina Corp. Riegelwood, N. C.

Fig. 2. Four-stage IMPCO vacuum washer showing console-type cabinet control panels at each stage

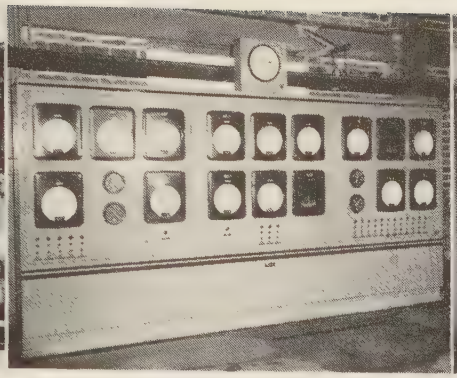

Fig. 3. Vacuum washer main control panel

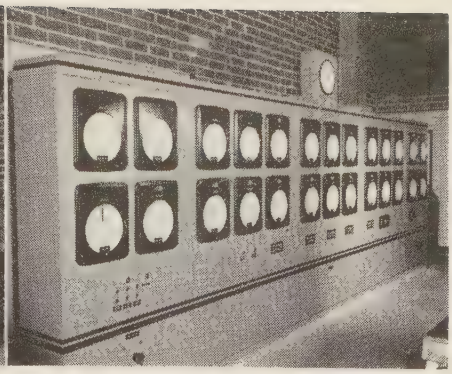

Fig. 4. Bleach plant control room

trols the flow of water to a De Zurik consistency regulator. A Fischer-Porter flow controller controls the flow of stock to the screen headbox.

Other sections of the mill where Foxboro instrumentation is utilized are the recovery room where smelt dissolving tank density control is in operation, the lime kiln, and the water and causticizing plants. In the Dorr causticizing area, the instruments panels again are placed in control rooms for protection and centralization. One of the more interesting instrument applications in this area is the recording of torque on the Bird centrifuge by means of the electronic Foxboro Dynalog and Baldwin strain gage.

The types of measurement made by Foxboro in the new Riegel mill for indicating, recording, and controlling purposes are temperature, temperature difference of two measurements, pressure and vacuum, flow rates and totals, level, density, conductivity, pH, consistency, motor load, torque, revolutions per minute, and oxidation reduction potential (ORP).

The instrumentation in the power department is basically Bailey instruments and controls. These are in connection with a Combustion oil or pulverized coal-fired power boiler, a Combustion refuse burning boiler, a turbine room installation, and a pump room installation. The instrumentation was engineered and designed by the combined efforts of the Combustion engineers and Bailey Meter Co.

The instruments and control stations for the power boiler and refuse burning boiler are on one large panel board, Fig. 7, located convenient to the operator. The system for the power boiler operates to automatically maintain the steam pressure in the header at a pre-set value by control of the fuel and forced draft. This is done by readjustments to the forced draft, being affected by means of the steam flow-air flow ratio controller. Separate control of furnace draft is achieved by means of a furnace draft controller which operates to control the speed of the induced draft fan turbine. Oil temperature and pressure are controlled at the desired value and recorded on the main panel board. The pulverized coal system is set up to control the fuel feed and exhauster inlet damper position for each of the pulverizers from the steam pressure index. Each pulverizer is equipped with separate coal-air temperature controllers to admit tempering air as required by action of a tempering air damper control drive. Flame detectors are provided at each burner which actuate indicators and signal in case of flame failure. A set of interlocks is provided to shut down the forced draft fan and fuel in case of loss of the induced draft fan and a time delay relay allows sufficient time to purge the furnace before resuming operation. Air heater gas and air temperatures are recorded on a four-pen recorder. The steam temperature is recorded with the steam pressure on the Bailey master controller. Feedwater flow and boiler drum level are recorded on the same panel board convenient for observation by the operator. Bailey multipointer draft gages are provided for indication of operating pressures within the boiler and air heater.

The control system for the refuse burning boiler operates to regulate the forced draft to the furnace by actuating the inlet vanes of the forced draft fan. Furnace draft is controlled by a separate controller which operates the induced draft fan dampers. Overfire air and windbox air are both controlled simultaneously by a ratio controller as a function of the pilot-rol in the Bailey steam flow-air flow controller. Multipointer gages are also provided for indicating furnace draft and combustion air pressures.

Process steam distribution, recording and integrating, meters are located on the turbine room panel board. This board is located at the head end of the turbine and includes the 50 and 150-lb. extraction pressure and flow recorders. Bailey desuperheater recorders for the extraction lines record the steam temperature before and after the desuperheaters.

The pump room instrument panel also furnished by the Bailey Meter Co. is located in the pump room convenient for observation. Included on this panel are steam distribution

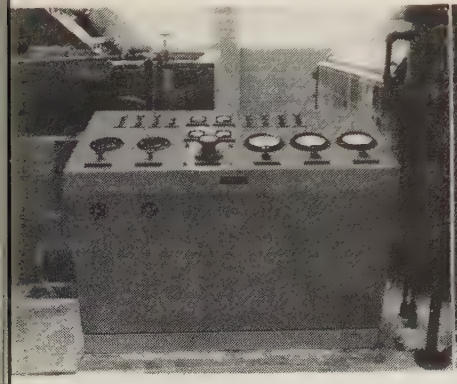

Fig. 5. Bleach plant console control panel

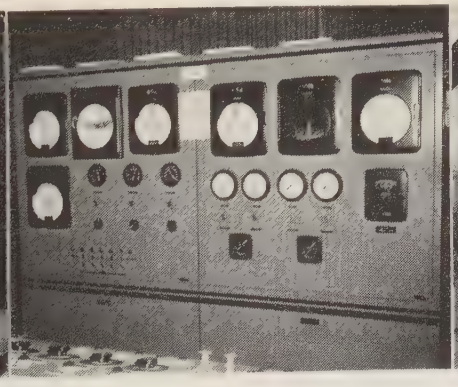

Fig. 6. Foxboro pulp drier instrumentation with Fischer-Porter Flowrator

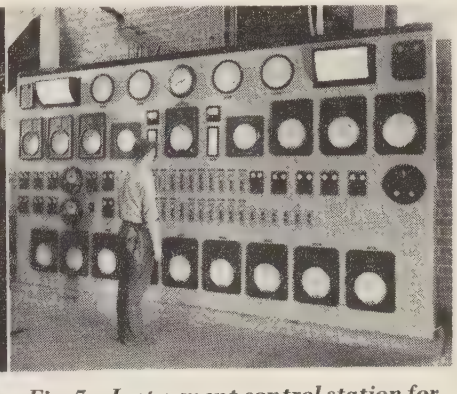

Fig. 7. Instrument control station for power and refuse burning boilers

recorders and integrators, boiler feedwater pressure indicators and recorders, deaerating heater temperatures, and level indicators with a high and low level alarm.

The instruments necessary for the efficient operation of the recovery furnace are located on a Bailey panel board. These consist of a Leeds & Northrup furnace draft controller, Bailey steam flow, steam temperature and boiler feedwater flow recorders. A Bailey ten-point multipointer indicator gage indicated the necessary drafts and pressures for operation. Also located on this main panel board are Foxboro recorders and controllers for the control of the Baumé and level of the smelt in the dissolving tank.

The cascade evaporators have a separate auxiliary panel which includes primary and secondary black liquor heater controller and a cascade level controller. These are Minneapolis-Honeywell recorders and controllers and are located behind the boiler and in front of the cascade evaporator.

Individual air compressors for the operation of the power plant instruments are provided in case of mill air failure. These are set to maintain an air supply in case of emergency to prevent the instruments from becoming inoperative.

Use of Chlorine Dioxide for Bleaching in Nonintegrated Paper Mills

HAROLD R. MURDOCK

In spite of ample evidence that chlorine dioxide is a splendid chemical for bleaching wood pulp, the paper industry hesitates to adopt the process. This postponement is not because of shortages in materials of construction, or chemicals. It stems from indecision as to whether chlorine dioxide bleaching is economically adaptable to paper mill operations. The industry seems to believe that the process necessarily requires burdensome capital expenditures and involves technical knowledge beyond the present requirements of the average paper mill. For these reasons the paper mills preferred that market pulp mills use this bleaching process in mass production in order to meet the paper mill needs for an ultrastrong, high-white wood pulp. However, chlorine dioxide bleaching can today be a very useful, flexible process for the paper mill.

It is true that chlorine dioxide is a troublesome chemical to handle. It is a toxic gas quite similar in properties to chlorine. Unless precautions are taken this gas explodes in the presence of light, and dry organic substances when in contact with this oxidizing gas may ignite. When mixed with air, the concentration should be kept under 5% to safely avoid explosive mixtures. Because of this instability and corrosiveness to most metals, chlorine dioxide cannot be shipped in pressure cylinders similar to chlorine. The consumer has no alternative other than to manufacture his requirements of chlorine dioxide, but paper mills can do this without encountering these hazards which seem so real.

The basic raw material for producing chlorine dioxide in a market pulp mill is sodium chlorate (not chlorite). By selective reduction using numerous chemical compounds chlorine dioxide is synthesized from the sodium chlorate. Consequently, many potential processes are possible but only a few are of practical importance. Years ago an extensive fundamental study of the reduction reaction between sulphur dioxide and sodium chlorate either alone or in the presence of acids was made by Mathieson Chemical Corp. This research culminated in their basic U. S. pat. 2,089,913 (Aug. 10, 1937). Later Gustav Holst, in Sweden, studied the reaction. From the basic Mathieson data he developed certain specific conditions of operation which constitute the principles of the process now in use at the sulphate mill of H. R. MacMillan Co., Nainamo, B. C. At Skutskar, Sweden, the Stora Kopparburg sulphate mill has installed a commercial generation plant using chromium sulphate as the reducing agent for the chlorate. This Persson process is reported to have some advantages over the Holst method because of higher chlorine dioxide yields. Other methods, such as the hydrochloric acid reduction process, have been suggested but all of these processes have at least one important objection from the paper mill viewpoint, namely, the high investment cost for a chlorine dioxide generation plant. It is reported that a generation plant adequate for a 300-ton bleached sulphate mill costs well over $120,000. Paper mills who use much smaller amounts of bleached pulp than that produced daily by market pulp mills cannot afford this large expenditure and the inescapable operation problems. The sodium chlorate (not chlorite) processes are not adaptable readily to the average paper mill operation.

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There is another chemical which paper mills are finding to be more adaptable for their production of chlorine dioxide. This chemical avoids the high capital cost investment and gives excellent bleaching results. This chemical, sodium chlorite (not chlorate), is available either as a solution in tank cars or as a crystalline solid in sealed drums. It can be stored, handled, and shipped safely. Mathieson Chemical Corp. have pioneered the production and application of this new chemical. They market a commercial grade under the trademark C_2 and license the use of their patents for a nominal fee. But the best feature of all is that this chemical can be used without having to separate or handle the chlorine dioxide. It may be produced in the water containing the wood pulp to be bleached.

There are three methods for converting sodium chlorite into chlorine dioxide. The first is to add sodium chlorite to an acid solution. The second is to add an alkaline hypochlorite to the sodium chlorite solution. This alkalinity avoids the need for acidproof equipment. The third procedure is to bubble chlorine gas through a solution of sodium chlorite. Each of these processes can be accomplished within the water-pulp suspension and avoids the need for handling the troublesome chlorine dioxide gas. But, if desired, the gas can be generated and absorbed in a water solution for addition later to the bleaching equipment. Many combinations of these several methods have been used in paper mills already. Selection of the method to use depends upon the type of equipment available in the mill, the degree of bleaching, and the quality of wood pulp desired. Each paper mill can select their preferred procedure. Recently, combinations of chlorine and chlorine dioxide have been used with distinct economic advantages and with pulp quality equal to when chlorine dioxide is used alone. In other words, the cost of chlorine dioxide bleaching cannot be measured merely by the cost of sodium chlorite. The Mathieson process places controlled bleaching of wood pulp well within reasonable economic reach of the small paper mills.

Before long, supply and demand for wood pulp will be in balance. When that time arrives, paper mills will not be obliged to place availability of pulp supply ahead of quality and uniformity of purchased pulp. Paper producers will then choose their wood pulp supplier on merits of pulp quality. Market pulp producers, on the other hand, will have to operate competitively to the lowest price and highest quality desired by the paper mill. The market pulp producer will prefer to manufacture one quality and brightness of wood pulp day after day. By so doing, he will avoid wash-up and changeover slowdowns and maintain a high daily average production produced at the lowest cost. He will try to select that pulp quality which can be sold readily to meet a large sustained tonnage production although he will find it necessary to make some other grades.

Of the approximately 400,000 tons of bleached sulphate market pulp consumed in 1951 by United States paper mills,

obably not more than 100,000 tons approached the quality of chlorine dioxide bleached pulps. A considerable portion of this quality pulp was evidently bleached by multistage hypochlorite bleaching methods although the chlorine dioxide pulps produced by MacMillan Stora, Kopparburg, and possibly other mills could have accounted for at least one half of this 100,000-ton estimate. The present demand for such quality pulps does not seem sufficient to induce more market pulp mills to install chlorine dioxide generation equipment with which to produce these superior pulps. In the future, such pulps will unquestionably find increased demand but the incentive for such growth will be due at least partially to lower selling prices where the pulps approach the more normal differential of 25 to 30 dollars per ton between fully bleached and strong unbleached sulphate pulps. With reduced profit margins the incentive to the market pulp producer will dampen. Severe competition may influence some market pulp mills to rather install chlorine dioxide bleaching equipment, but such decisions will be tempered probably by paper mills installing their own facilities for producing high brightness strong pulps.

The problems encountered in paper production are difficult ones. The papermaker is expected to produce many types of papers when requested by the sales department. If he is resourceful, he usually succeeds when he has adequate facilities. Pulp quality is the chief raw material problem. The desire of the papermaker to carry a large diversified pulp inventory is understandable. At times, however, he finds that the brightness of a purchased pulp does not always reflect the final paper brightness. He is prone to blame the pulp producer but doing so does not solve the immediate problem of matching competitive papers promptly. Sometimes the papermaker finds his purchased pulp to be brighter than required to make certain papers. Coloring back with dyestuffs is not easily accomplished or always reproducible.

With a chlorine dioxide bleaching process as an integral part of the paper mill operation, such problems in paper production can be easily controlled. The Mathieson method is simple to operate and is available to any paper mill at a moderate capital investment. This bleaching process gives the papermaker a unique means to control strength characteristics and brightness at the paper machine. With automatic controls the bleaching can be kept at a uniform standard of performance. By using low color pulps which have been produced in a continuous manner under careful control by the market pulp producer, the paper mill bleach plant possesses a reliable, uniform raw material. One paper mill, for instance, believes that with a chlorine dioxide bleaching plant, their pulp inventory can be reduced to a few standard grades. Their bleached kraft pulp requirement for processing will be a single market pulp of around 75 brightness. When purchasing market pulps of such relatively low brightness, the competitive position is broad, and these mass production pulps follow stable price trends. On the other hand, high-brightness pulps have a limited market because of fewer customers. Consequently, they sell well above the cost of low brightness pulps.

Serious errors are being made today in estimating the potential cost of bleaching pulps by sodium chlorite. It is not realistic to use present prices of sodium chlorite in determining the eventual long-range utility of the process. Today, sodium chlorite is produced for industrial uses in only a small pilot plant. In another year full-scale plant production can be anticipated with a substantially lower production cost. Another factor which will lower the cost of the process is new technological developments now in progress. The science of producing sodium chlorite and the application of this chemical to pulp bleaching have by no means been completed. Potentialities for more effective use of the chemical are already on the horizon. Consequently, a paper mill with its own chlorine dioxide bleaching process has many cost advantages. Already it is clear that the mill does not have to carry as large an over-all pulp inventory and also the mill can bleach low brightness pulps to a desired paper requirement, at a cost usually less than the market price differential between low and high brightness pulps.

Therefore, a paper mill can obtain the best raw material cost and operation by purchasing moderately bright pulps, produced in large tonnages by market pulp producers, and then bleaching these pulps to such brightnesses necessary only for current paper orders by using the modern chlorine dioxide bleaching process. Selection of the bleaching process details and equipment should be done carefully under supervision of engineers experienced in this modern effective process.

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THIRD TAPPI COATING CONFERENCE

Hotel Sherman, Chicago, Ill.,

May 5–8,1953

Considerations in the Selection of Equipment for Coating Preparation

J. T. LOOMER

I MUST confess that the approach to the subject of this paper was made with some hesitancy. In all fields and types, the coating industry has expanded so rapidly that the amount of literature relative to the process and operation of coating preparation is almost nonexistent. The available literature is concerned with the characteristics of coating before it's made and after it has been used. Seemingly, the ability to write a formula for a coating connotates complete understanding of all the processes involved in coating preparation. The shorthand of the coating formula leaves a distinct impression that something is missing. And the "missing something" is usually a breakdown of how the coating is actually prepared. The literature today is noteworthy for its absence of flowsheets, specifications, layouts, and machinery for the preparation of coating color.

It is not the purpose of this paper to be dogmatic as regards the design of a coating plant. I have neither the knowledge nor experience. I simply propose to erect a skeleton on whose bones can be hung the flesh of actual production know-how by people familiar with the operations entailed. By discussing briefly the factors involved in the design of a coating plant, it is hoped that others in the field will be incited to discuss, in more detail, particular phases of coating preparation.

INITIAL CONSIDERATIONS

The prenatal care of the design and delivery of a coating color preparation plant consists first in a series of questions and answers. The questions for the most part are addressed to management. In brief, the big first question is how much coating of any and all types will be required. In particular the initial questions might occur as follows: (1) the total tonnage to be coated: (2) how many types of coating will be used, (3) in what tonnages will the types be needed, and (4) the probable sequences of operation or use of the different types of coating.

These are possibly the main questions for management to answer. And these answers must and should be obtained as early as possible. For in the design and layout of a coating operation remission for overdesign or overcapacity is more easily forgiven than underdesigning. Basic design may be for the full capacity of the coating machine.

There is a great deal of dynamite packed into the foregoing questions and the speculations regarding demands must be thoroughly exhausted to insure successful and satisfactory design of the coating installation. It is one thing to design a plant for a one-machine operation and another to ask it to handle two machines. Some of the questions cannot be fully answered but make it a point to accumulate all the information possible that bears in any way as to probable answers. Along this line, just one point in passing—attempt to have managemen set up a run policy to group orders thus enabling sizable runs. Some coating plants cannot be operated efficiently on the theory of half batches. At the outset, attempt to have orders grouped, at least in the mind of management, to permit a more natural method of operation. If you have 4 days' running time on coated orders try and run 4 days straight rather than splitting them to 1 day per week. In this way you can protect your design by guaranteeing maximum tonnage of coating demands.

INVENTORY REQUIREMENTS

The second step is the reduction of the requirements into actual needs. Translate the output of finished coated stock into terms of pounds of coating required. Be sure and do this for all grades and in every case use the maximum pounds of coating normally applied. Don't forget at this stage the different types of coating—the preference of industry for certain types. Here I'm not being specific but general, and refer to coatings for letterpress, offset, or colored coatings. At this stage we must now revert to the coating formula. Convert pounds of coating by means of the formula into raw materials requirements on a daily basis. Ascertain now the distance the mill is from the point of shipment of each of these raw materials and you can then determine your minimum inventory requirements. This is further broken down using the formulas into relative amounts based on either the largest quantity of material in the formula or the smallest amount. For example, on a clay basis you might use 20% of as much starch as clay. Or on a dispersant basis you might use possibly 350 times as much clay as dispersant. Your relative quantities combined with the raw materials delivery will dictate storage space for each material. The minimum amounts are by no means selected but are to be used as a guide in determining what inventory you can safely carry. Too many of us during the last war awoke to the frailties of rail shipments in attempting to forecast deliveries. So have plenty of leeway for raw materials storage and stockpiling if necessary.

COATING DEMANDS

Return now to the demands of the machines. Convert the tonnage to be coated by means of the formulas decided on into the volume of coating to be prepared on a daily basis. At this point you have a decision to make regarding labor. Most mills run three shifts and, if possible, it may be advantageous to depart from a daily basis and consider the coating preparation in terms of how much is required per shift. By doing this you can equalize the work to be done on each shift. Or your process and demands might lead to a one-shift operation carrying two, or two shifts carrying one. In this day and age labor is an important raw material and must be considered as such. Bear in mind in determining the plant capacity you must attempt to equalize the demand on labor. To clarify this point, you can answer the following questions:

1. Can all the coating be prepared on one shift to coast for the other two?
2. Can all the coating be prepared on two shifts to coast the other one?
3. Should the coating be prepared equally on all shifts?

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With the above answers you are now in a position to consider the actual layout and location of the coating plant. Basically the coating plant has three divisions—storage, preparation, and storage for finished coating.

PLANT LOCATION

In a great many cases the installation of a coating plant is made in an existing building. Rarely is the opportunity offered to start from scratch. And in many paper mills the coating plant is installed in perhaps what was formerly mill storage space. This location may or may not be near the coaters. It is desirable, if possible, to reduce the distance between coating storage and the coaters but in many cases this is not entirely feasible. But in any event the location of the coating plant should have at least the following characteristics.

1. Storage of raw materials and coating plant should be close together.
2. Location should be clean, preferably on the lee side of the mill to eliminate cinders, fly ash, and other objectionable materials from contaminating raw materials and finished coating. By the same token keep it away from the machine shops or any dirty grinding operations.
3. Walls, ceilings, and floors should be smooth finished offering no possible space for dust or drained coating to accumulate.
4. The location should have access to excellent sewerage disposal or good drainage. Bear in mind the possibility of stream pollution from coating washups.

I have listed the minimum requirements. In actual practice if the coating operation is installed as an appendage to a paper or board machine it may be difficult to meet any of these requirements. However, they should be adhered to as nearly as possible.

MATERIALS STORAGE

The storage and handling of the raw materials used in the coating should be based, if possible, on the "fifo" or first in first out scheme of usage. This is readily apparent in the use of the urea resins. It also gives the raw materials control laboratory a fighting chance to detect variations in shipments of the raw materials. Handling on a "lifo" or last in first out basis can be troublesome as changes in raw materials come gradually and the opportunity of absorbing these gradual changes is missing in this type of a materials handling program. You may be confronted with marked differences in flow characteristics between fresh and old materials under the lifo plan. Segregate and mark plainly, if possible, individual shipments to make their identification easy in case of trouble.

In brief, all coating raw materials are shipped in one of the three following categories: bulk, bags, or drums.

Bulk shipments are usually discharged by mechanical or pneumatic conveyors directly to bins or silos. Clay in slurry form has been shipped successfully in tank cars, however, I believe the economics of this method of shipment do not justify it in competition with hopper or freight car bulk shipments.

Bags can usually be handled by regular bag or belt conveyors. The recent war emphasized the shipment and storage of materials in a palletized form. The pallet in combination with the lift trucks has proved to be the answer to the storage and delivery of materials in many mills.

I pass over the handling of the raw materials somewhat lightly as most of the raw materials of coating have been handled by mills prior to any coating operations. Furthermore, in this particular field the companies specializing in the handling of raw materials can adequately provide detailed and specific information to fit a particular need or location.

One important interjection at this point, keep the raw materials clean as well as their storage space. Too often suppliers of raw materials have received dirt complaints due to materials that lodged on the outside of bags and were introduced into the coating mix when the bags were emptied.

PLANT LAYOUT

A word now about the physical layout of the coating plant. How many levels should a coating plant have? In the past usually it has been a three-level proposition. Flowing downward from the top from storage to preparation, to coating storage. Most plants are built at two levels, or one and one-half levels, an operating floor and a platform or tank level catwalk. The tendency, I believe, today is to use gravity flow of materials when feasible but not to worry about it if gravity flow can't be used. In my own opinion there are more gravity gremlins than pump gremlins. Too many valves open mysteriously to empty tanks by gravity. A pump usually offers resistance to flow and the starting or stopping of a pump can be more of an assignable cause than the opening or closing of a valve.

The election of what a coating plant will consist of as far as levels go is usually a matter of location, and from the standpoint of producing a usable grade of coating there is no essential difference. The gravity systems would have some advantages possibly in the handling of dilatant slurries.

METHODS OF COATING PREPARATION

Today, there are three general methods of coating preparation. These are as follows:

1. Individual materials preparation—Pigments are dispersed in a slurry form. Adhesives are prepared (slurried, cut, cooked, and converted). The two dispersions are blended together.
2. Adhesive preparation with pigment addition—The adhesive is slurried, cooked or converted and the dry pigment is dispersed in the prepared adhesive.
3. Simultaneous preparation—Both pigment and raw adhesive are co-dispersed. The mass is then treated to cut or solubilize the adhesive in the presence of the pigment.

The method of individual materials preparation has had the most widespread usage in the industry. This is quite natural as this particular method had been used for years in brush coating. The equipment involved has been low cost and fairly commonplace. Agitated tanks were the base equipment. This method is running into some difficulty in the fields of machine coating where demands for high solids in the finished coatings sometimes require that the individual components be pushed into the realm of dilatancy in order to preserve the water balance. At 70% solids dispersion of certain clays is extremely delicate. In the preparation of a clay dispersion the too rapid addition of clay to the mixing tank can throw the slurry into a dilatant condition which being localized can overload mixers or agitators. Starch dispersions do not normally exhibit dilatant characteristics of a troublesome nature until they enter into the range of about 40% solids and upwards. A 60% solids coating with 20% starch based on the pigment requires cooked starch at about 35% solids to be added to a clay slurry at 70% solids. Furthermore, if the adhesive is prepared by cooking with direct steam even higher initial solids are necessary at the outset to compensate for dilution by steam condensation. Preparation of high solids protein coatings by this method may be difficult due to the high water requirements to establish flow and dispersion of the protein. If this method of coating preparation is to continue in use for high solids coating it is almost mandatory that we be able to disperse and cook starch slurries at much higher solids—possibly around 50%. Both the starch companies and the individual mills are aware of this necessity and work is now in progress to overcome this condition. This method of individual materials preparation is fairly trouble free for coatings up to 55% solids depending, of course, on the ratios employed. Above this range trouble may be encountered unless certain safeguards are used.

The second method—adhesive preparation with dry pigment addition—is not new to the industry. In terms of equipment it is possibly the highest first cost as the equipment employed is the high shear dough mixer or kneader. In

comparison with other types of dispersers the kneader is by far the most positive but usually also requires the greatest horsepower. Batch sizes usually do not run over 750 gal. although I believe special designs of larger sizes are being constructed. The preparation of coating by this method offers none of the drawbacks as in the method of individual materials preparation since the liquid phase of the finished coating color can be used entirely for the adhesive preparation.

The third method—simultaneous preparation—makes use of the equipment either in the first or the second foregoing methods. Possibly the most publicized technique under this heading is the Craig process for the conversion of starch in the presence of the pigment. The principal superficial objection to this method when employed with starch coatings is, of course, the necessity of heating the pigment phase of the coating color. In order to solubilize or treat the adhesive it is necessary to put all the other phases of the coating through the same mechanics. With protein adhesives the kneaders permit cutting of the protein in the presence of the pigment.

PIGMENT DISPERSIONS

Pigment dispersion is usually accomplished by either of two methods, high or low shear. Examples might be as follows:

1. Tank with paddle agitation.
2. Tank with paddle agitation supplemented with additional dispersion by cycling contents through a high volume, low head centrifugal pump or color jordan.
3. Turbine type agitation.
4. Propeller agitation.
5. Kneading machine or dough mixers.
6. Pigments dispersed at the clay mines and shipped in tank cars.

The fairly recent introduction of the predispersed clays has helped somewhat to relieve the headaches in the first four methods. Recent work on the reduction of adhesive demand of pigments have highlighted the use of the kneading machines. Methods 1 through 4 are suitable for low solids slurries. Methods 1, 2, 3, and 5 are usually employed for high solids slurries. The kneading machines are again possibly the most efficient method of pigment dispersions but again are the highest first investment cost.

Irrespective of the method of dispersion employed the following factors must be observed.

1. A controlled addition of pigment to the dispersing unit.
2. In some cases also a controlled addition of water.
3. An insurance of the correct amount of fresh dispersant.
4. Adequate laboratory checks on raw materials to catch and allow for any deviation from standards.

ADHESIVE PREPARATION

Discounting for the present time the use of the water-soluble gums, there are two main coating adhesives in present use, starch and proteins.

Protein preparation: the standby for the preparation of protein adhesives has usually been the paddle-type cooker which may be heated by a steam jacket or direct steam. In practice, the protein is discharged directly into the cooker filled with cold water, allowed to wet and disperse, brought to temperature, and the chosen cutting agent dissolved in water is added. Protein water dispersions are usually dilatant in nature and can be handled more readily in a cut condition.

Starch cookers are also of the paddle type heated by direct or indirect steam. Many mills employ a starch dispersing tank similar to the equipment used for clay dispersions. The starch milk is then screened from this wetting tank directly into the cooker.

EQUIPMENT

All equipment employed in any phase of coating preparation should, of course, be resistant to chemical action of the coating as well as the individual components. Plated or painted surfaces are questionable investments. Loosening of paint or pitting of plating can contaminate coating batches very quickly and in the end units so treated are out of service. Take tips from the food industry in equipment selection for although coating is not very appetizing it needs the same sanitation and sterilization care as food. You have only to coat with a spoiled batch of coating to hear from the customer and the sales department.

Tanks. All tanks and cookers should be smooth finished and free draining. Covers for all tanks should be standard equipment to keep the contents clean as well as prevent skinning over due to hot materials or use of latices. Tank location should be such that headroom equal to agitator length is available. Cleanout or cover openings should be ample to permit the entrance of a man if scraping is necessary. Best height to diameter ratio seems to be a minimum of 2 to 1. Wooden tanks are to be avoided unless lined due to difficulties in clean-ups.

Agitators. The paddle-type baffled agitator is possibly the most popular. Speed and rake of the agitators should be selected to avoid air entrainment. On jacketed tanks, agitators should ride as close as possible to the jackets. Side-entering propeller-type agitators can be a source of trouble if tank levels are not controlled. Take advantage of difference in specific gravities to aid mixing. Add heavy materials to light materials such as a clay slurry to a starch slurry.

Differentiate between mixing and agitation in the selection of the agitators. Obviously the function of the storage tanks is to keep the materials in suspension or prevent reversion to a gel. The storage tanks can then require slower agitation than the blending tanks.

Drives. Gear reduction drives are possibly the most popular. Watch such drives for leakage which can contaminate coatings. Offset drives were possible. I personally favor V-belt drives where feasible due to the safety factor for V belts. On horizontal gear drives, such as on kneaders, put safety covers on the gears but not so well that they cannot be inspected and lubricated easily. I've lost a set of kneader gears due to the overlooking of this condition.

Motors. If possible, make all floor located motors totally enclosed. The average man with a wash-up hose can refute the manufacturer's claims for a motor being splashproof. The most important point—see that the motors are running in the right direction. Too many times and in too many cases the electrician has determined that equipment will run opposite to the manufacturer's design. Don't pass over this point lightly but check direction of rotation with the manufacturer's drawings showing direction of operation. Install motors to drive down to pumps so they are off the floor for wash-ups.

Switches. The tendency today is toward the central control panel but locate individual start and stop switches at pumps and motors. Long-distance calling out of "On!" or "Off!" when checking motor or equipment operation is costly and annoying. If possible, locate switches in sight of equipment they operate. With all the advantages of push-button starting it still is a human trait to see if the button really started the pump. Pilot lights on switches should be used if it is not possible to sight the equipment.

Heating. Usually it is either direct or indirect. Jacket heating is more costly but the use of jacketed cookers offers also a means of cooling and avoids dilution by condensation. Sometimes it is advisable to jacket tank bottoms only as a source of heat for temperature control or tank boil-out. On all types of direct steam cooking provide vacuum breaks on lines to avoid suckback of material being heated when steam is turned off. All pressure equipment should, of course, be vented. Equip steam lines with adequate traps and insure that they work. Use clean steam. In plants equipped with steam engines oil may accumulate in the condensate and ul-

in ately find its way into a direct heater. The use of specially onstructed nozzles for direct steam heating is advocated.

Piping. The streamlined or soldered fitting piping is sually used to induce a minimum of pipe friction. Avoid rp bends and use long radius elbows if possible. When a ends or curves sharply put in plug or valve line washouts. serve the internal diameter of the lines. If you insert a ermometer bulb make the line at the point of insertion rger. For coating supply always use a circulating line from corage to coater and back to storage. Don't dead end any s. Secure pipe to buildings and not to pumps. If it is essary to run coating lines outside of buildings, insulate ith a small steam line next to pipes.

alves. Avoid the use of valves such as gate or globe. The oth flow diaphragm type or pinch-type valves are less ble. Plug valves can be used to avoid dead-ending ps. On all air or electrically operated valves, check ting of valve prior to installation. It is an excellent idea se the tag indicators on valves to show whether they are or closed.

Pumps. Positive pumps are normally used on all coating eries. With the use of positive pumps a relief valve uld be employed or some insurance that they will not running against a closed line. Some of the pumps will w a line open before they overload or break down. This n be very embarrassing especially if the blow occurs in e place not readily visible. Usually the coating plant erator wonders why the machine is using so much coating fore it dawns on him that something is wrong. Remember at prior to any screening operations coating materials may abrasive so select suitable pump materials and packings. here plunger-type water lubricated pumps are used be reful of coating dilution by the water lubricant. Axial w pumps can also be used advantageously.

Centrifugal pumps for slurries or as an aid to dispersion are ually of the open impeller type. Cases have been reported air binding on these pumps due to entrained air in the spersions and the pump concentrated it. Use large volume w speed pumps.

In general, don't try high velocity pumping on coating aterials. Use pumps large enough to get capacity at slow eeds.

To govern the selection of pipe and pump sizes in terms of pe friction and work to be accomplished, a recent article B. O. A. Hedstrom entitled, "Flow of Plastics Materials Pipes" is recommended reading. This appeared in the arch, 1952, issue of *Ind. Eng. Chem.* 44, No. 3: 651–656.

PROPORTIONING OF MATERIALS

The coating formula is set up on a weight basis, therefore come accustomed to measuring in pounds.

Dry materials can be weighed on platform scales or espe- lly designed weigh lorries or hoppers. You may use dry ders for pigment addition.

Liquids can be added using either scales or volumetric asurement in form of a calibrated tank.

Possibly the most convenient form of liquid addition is by ter. Properly used meters either calibrated in terms of lons or pounds are accurate and very convenient. If you n to use meters provide a meter washout on either side he meter to be used after each measurement. The meter ple can measure while the material is flowing but they do recommend the material to be allowed to gel or settle in meter body.

aning of Materials

Although the suppliers of raw materials take as many cautions as possible undesirable materials creep into a ting furnish. Coating after it's made and has been screened develop lumps. Fuzz can pick off a sheet and contaminate material in a coating pan or nip. The only protection for the coating plant are screens.

On slurries of low viscosity it is possible to use gravity-type screens where the rate of screening is not too important. For more rapid screening the vibrating or gyratory type are employed. Irrespective of what type screens are employed, equip them with overflows. Do as much screening as feasible on the components at low viscosities.

To supplement the above type screens on the finished coating, pressure-type, self-cleaning screens can be used. In this field to my knowledge the leaf-type edge filtration screen has been the most successful. Our own operations use one equivalent to a 70 or 80-mesh screen on delivery of coating to the storage tanks. These units are expensive and it is hoped that better methods of screening the finished coating can be found.

Ink mills in my opinion are not screens although they will tend to keep heavy particles from passing into the discharge. Ink mills in the modern method of coating preparation, again in my opinion, are not necessary.

Good housekeeping practices should be observed as a matter of course. Industrial vacuum cleaners should be used to clean the outside of bags prior to emptying them or bringing them into the loading zone. Ventilators and dust removal equipment should be used where necessary.

INSTRUMENTATION

The instrumentation of the coating plant can be as thorough as you care to make it. Where possible use automatic controls with recorders.

The possible measurements needed are: (1) temperature, (2) pH, (3) viscosity, (4) specific gravity, (5) solids content, and (6) level indicators. All these items must also be controlled. Temperature measurement and control are fairly well standardized. Cookers should be equipped at least with an indicating thermometer and in many cases the minimum control should be at least indicating and recording. More elaborate installations call for indicating, recording, and controlling by manual or a predetermined cycle arrangement.

Viscosity control in the early stages of starch conversion utilized the pressure drop through an orifice. A number of industrial in-line viscometers are available but being mechanical in nature are possibly troublesome. I have no working information on viscometers of this type. A fairly recent development in viscosity measurements is a viscometer based on sound. The initial literature indicates excellent industrial possibilities for measurement of non-Newtonian liquids.

The other items such as pH, specific gravity, and solids content are still mainly laboratory controls, although there is an instrument for continually recording specific gravity, I do not have any information as to its practicability in the coating field. Level indicators are fairly commonplace although possibly troublesome.

GENERAL

The supply or equipment industries can and will provide a great deal of help for specific engineering problems. Some manufacturers will install equipment on a performance basis. Discuss your requirements with a number of manufacturers. If you are attempting to create a coating plant circulate through the industry to see what others are doing. There are no installations however perfectly planned that when put on an operating basis don't reveal changes or alterations making for more efficient operation.

When feasible keep all equipment of uniform design for interchangeability.

Such is a skeleton outline of coating preparations. Most of it is probably very dry bones. It is not entirely complete or minutely detailed. It will probably need additions and corrections. These should come from the operating people of the industry.

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Large-Scale Preparation of Clay Slips

E. G. HESLOP and H. M. HUGHSON

The intent of this paper is to describe one of the many possible systems for the slipping, screening, and storing of coating clay: one which has proved itself most economical and flexible in a two-machine mill producing up to 175 tons per day of machine-coated paper at Port Arthur, Ont. Carload lots of regular machine-coating grades of Georgia clay are received from a number of suppliers and each carload is slurried to a 70% solids slip in a single 8-hr. day shift. The dispersion of the clay is completed by a further 8 hr. of circulation and agitation and the batch is then sent to intermediate storage. The slip is screened by passing over a flooded Hum-mer vibratory screen and is then pumped to agitated storage, ready for coating mixing. The system normally handles one car per day with two men on one shift doing all the unloading and controlling of slip solids content.

After nearly 5 yr. of use, this system has been shown to be economical to operate, moderately flexible at times of experimental runs, and capable of delivering a clay slip with minimum variations in solids content, minimum impurities, and the maximum homogeneity.

SCHEME OF OPERATION

The general scheme of operation can best be followed by tracing the course of a 45-ton car of bulk coating clay from the time it is spotted in the unloading shed until it is pumped as a slip to the coating mixer (Fig. 1). The car is spotted opposite a hopper of 1-ton capacity, into which the clay is first shoveled from the car door and from which it is carried by a variable-speed screw conveyor to the blunger. After the car door is cleared, the clay is carried to the hopper by the unloading crew, using 30-in. square scoop-type barrows, originally designed for unloading grain (Fig. 2).

In the blunger, a cylindrical steel tank 5 ft. in diameter and 7 ft. deep, with a perforated steel false bottom, the dry clay meets water metered in from the blunger storage tank. This concrete tank, measuring 8 by 8 by 26 ft. deep and agitated by a slow-speed paddle agitator, is partly filled with 2000 gal. of water prior to the beginning of the slipping operation. When necessary, a dispersing agent is added to this water, the usual amount being 5 lb. of tetrasodium pyrophosphate per ton of dry clay in the car. The water is metered to a small baffled leveling chamber by means of a Saunders valve, controlled by a bubble-tube level gage in the chamber, and thence it is delivered tangentially to the blunger. In the blunger, the clay is rapidly broken up and dispersed in the water by means of a high-speed 30-hp. agitator, consisting of two tooth-edged disks placed one above the other on the vertical shaft, and with the shaft situated one-third radius distance off-center in the tank. The resulting slurry is removed continuously from the bottom of the blunger by a 60-hp. centrifugal pump with a shrouded, wide-blade impeller which returns it to the top of the large storage tank.

The unloading of the clay is continued as fast as the crew can scoop it out until approximately half of the car has been slipped. A composite sample is then taken of the remaining dry clay, a rapid moisture determination is carried out on a small portion of it using an infrared lamp and a triple beam balance, and the remainder is sent to the laboratory for routine analysis. After the moisture content of the clay (usually 2 to 6%) has been determined, a nomogram is consulted in order to ascertain the theoretical amount of water needed to slip the original contents of the car to a 70% slurry. This volume of water, less the amount already charged to the storage tank, less also a safety factor of approximately 750 gal., is metered into the storage tank, and the unloading of the clay is continued at full speed.

The unloading continues for 4 to 5 hr. until the main pump ammeter starts to show an appreciable load at which point the speed of the screw conveyor is cut back slightly and the slip is sampled for a solids determination, arrived at by weighing a calibrated bottle. As the last of the clay is removed the speed of the conveyor must be cut back more and more with the crew making periodic references to such indications of solids content as the pump motor ammeter which should not be allowed to go above 35 amp., the appearance and sound of the slip under agitation in the blunger, and an air-bubble density recorder reading the density of the slip in the storage tank. During the unloading of the last 5 tons it is usually necessary to stop the dry clay addition completely for short periods so that the lumps in the blunger may be dispersed and the viscosity of the slip may be reduced sufficiently for the pump to remove it. Further density tests in this last stage usually determine whether more water must be metered into the storage tank or blunger in order to slip the remaining clay, the rule of thumb being that 100 gal. of water will cut back the solids 1%. However, unless the clay is excessively viscous or the car is an unusually large one, it is preferable to restrict the addition of water, in order to retain the obvious advantages of greater storage capacity and higher solids coatings.

After all the clay has been slipped, a sample is taken for a solids determination (oven drying) and the clay is circulated through the system, in order to complete the dispersing action. Laboratory tests on the final slips have shown that the clay agglomerates are at least 95% dispersed by these methods when compared with dispersions of the same clay prepared in the laboratory for a particle size determination according to the method described by Masterman (*1*). During the night the clay is pumped from the blunger storage tank to one of two similar large agitated reservoirs, known as "unscreened storage" tanks. Receipts are determined by means of depth measurements in the storage tanks and a final solids

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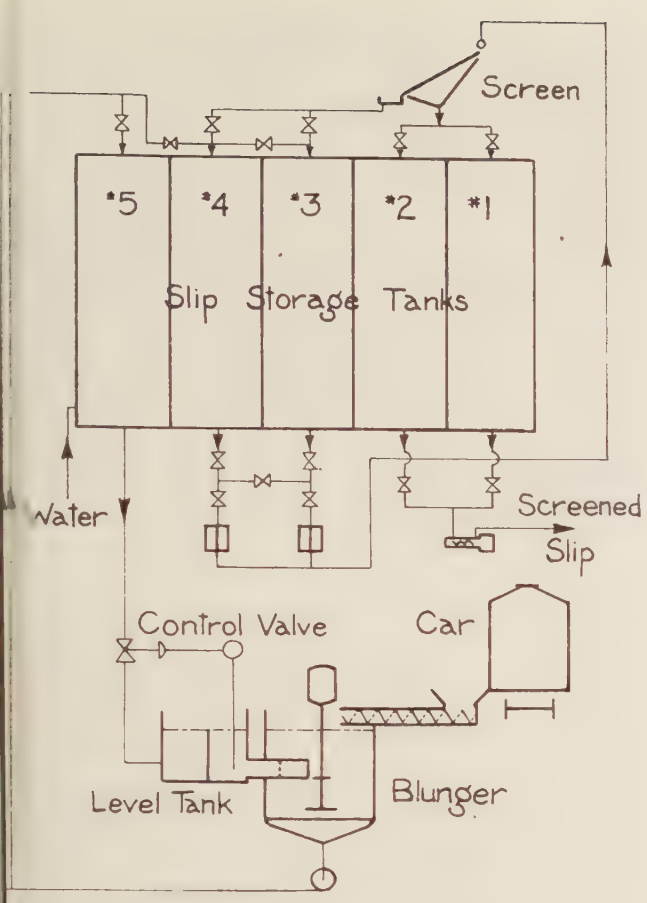

Fig. 1. Flow diagram

etermination on each batch, the total solids usually varying etween 68.5 and 70.2%. The per cent solids of the slips in n each of the screened tanks is determined daily, and these gures are used to calculate the amounts of water needed in ixing the coating.

As the clay is needed it is pumped from the unscreened torage tanks, by two 5-hp. triplex plunger pumps in parallel, o a Hum-mer vibratory screen on the top floor of the coating lant (Fig. 3). The slip is distributed over the full area of the nclined 150-mesh screen by means of a header pipe, so that y flooding the screen and returning the overflow to the unreened storage tanks, a throughput of $2^1/_2$ to 3 tons of ccepted clay (moisture-free basis) per hour is attained. The accepted clay is piped by gravity to the top of one of the reened clay storage tanks ready to be pumped by a 10-hp. Moyno pump to the coating preparation plant. All five torage tanks were made the same size, but due to grit from he concrete walls getting into the coating, it was necessary o tile-line the two screened storage tanks, giving them a ightly smaller volume. Each tank is equipped with a vertical agitator having four, 8-ft. oak paddles, driven at 10 r.p.m. y a 10-hp. motor. The unscreened storage tanks must be eaned out once a month to remove the accumulated grit nd lumps, which usually weigh 50 to 100 lb.

DEVELOPMENT OF BLUNGING EQUIPMENT

The principal reasons for designing a system such as is deribed above were that: (1) it was desired to reduce the andling costs to a minimum, (2) there should be minimum ontamination of the clay, and (3) only limited storage pace was available.

Once it was decided that the most economical and simplest stem was one in which the clay was slurried as it was unaded, and handled subsequently as a slip, it was necessary ascertain the maximum concentration to which the clay should be slurried. The available literature and the suppliers' specifications stated that even the finest American clays could be dispersed as 70% slips and these statements were confirmed by rough laboratory tests. Having ascertained that a 70% slip was free-flowing and could be easily handled, it was then necessary to select a design of dispersing apparatus that would give complete breakdown of clay agglomerates in the minimum time with the least expenditure of power and at minimum capital cost. The most important factors influencing design were the shape of the agitator, its speed and power input, the size of the slipping tank, and the amount of dispersing agent required.

When small-scale trials with low-speed paddle agitators failed to yield slips of more than 67% solids after a very long dispersing time, it was deemed necessary to carry out further trials in a mill coating mixing tank fitted with a single 10-hp. disk-type agitator, rotating at 340 r.p.m., the 2-ft. diameter disk being fitted with four crescent-shaped adjustable buttons. With this equipment it was found possible to slip 2900-lb. batches of clay in 1 to 2 hr. to the desired 70% solids. Experience showed that the dry clay could be added to the water as fast as bags were dumped, up to the point where the total solids tested at 65 to 67%, when it was necessary to reduce the rate of addition considerably. Several hours of agitation were needed before all the lumps from the final additions of clay were completely dispersed. In these and in all subsequent trials, an appreciable rise in temperature of the slip was noted, amounting to approximately 4°F. per hr.

Later a more flexible experimental apparatus was built with a 50-hp. motor driving a rotor whose vertical and horizontal position could be adjusted within a 4-ft. diam. steel tank. In this equipment, using the bottom-type agitator, set one-quarter radius distance off-center, 1700-lb. batches of clay could be dispersed in less than 30 min. with the last lump disappearing in $1^1/_2$ hr. time. The peak of the horsepower input was reached shortly after the last of the clay was added, and then it was seen to drop gradually as the coarser agglomerates were broken down and the viscosity reduced.

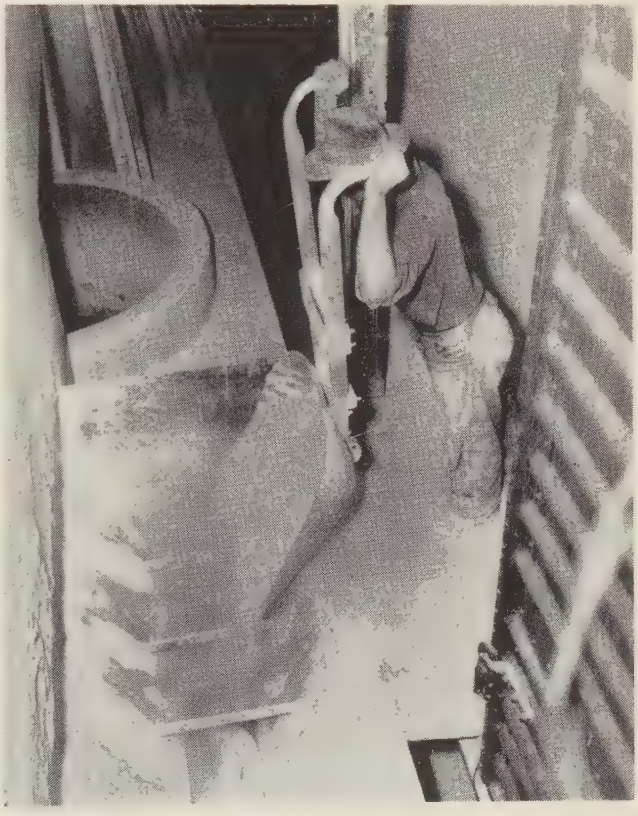

Fig. 2. Unloading a clay car

Later experiments with a higher speed motor (1600 r.p.m.) and a new design of rotor, set one-third radius distance off-center, gave even faster slipping with less vortexing and splashing. The new rotor consisted of a 9-in. diam. cast iron disk with thirty $^1/_2$ by $^3/_4$-in. teeth set around the top and bottom circumferences and making an angle of 50° with the radius. This rotor seemed to give a better action with less vibration, and a number of experiments were carried out with it to determine the best position for agitation and the optimum amount of dispersing agent for fastest slipping with minimum final viscosity. Results with this apparatus showed that up to 75% of the dry clay could be added rapidly, but after this point the rate of addition had to be progressively reduced.

Based on these experiments, the final design for a plant capable of handling up to 50 tons of clay per day was decided upon. The steel blunging tank was made 7 ft. deep, 5 ft. in diameter, with a false bottom of steel plate perforated with 3-in. holes (Fig. 4). A 30-hp. motor was considered adequate and since one of this size, with a speed of 1160 r.p.m. was available, it was installed, with the shaft 10 in. off-center. The 30-tooth, 9-in. diam. rotor was placed at the bottom of the shaft, 5 in. above the false bottom, but power tests on the motor during slipping trials showed it to be drawing only a small fraction of the total power available therefore, experiments were carried out with larger rotors, and best proving to be one with a diameter of 13 in. and 40 teeth. The addition of a second rotor of 9 in. diam. and 19 in. up the shaft from the first, helped to minimize vortexing and to break up newly added clay without drawing an appreciably greater amount of power than the 13-in. rotor alone. It was found that the rotors suffered a surprising amount of wear so that it is necessary to replace them approximately once every 4 mos. Slipping was later speeded up by adding the dry clay closer to the center of the tank, which was achieved by attaching a spout at the delivery end of the screw conveyor.

Most of the inorganic dispersing agents recommended by such writers as Asdell (*2*) were tested, but the most economically attractive proved to be tetrasodium pyrophosphate

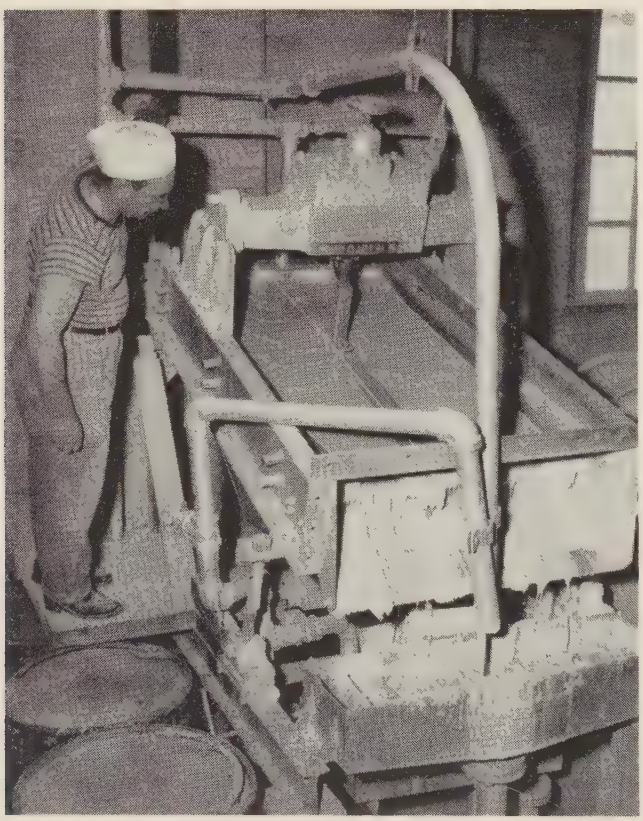

Fig. 3. Screening the clay slip

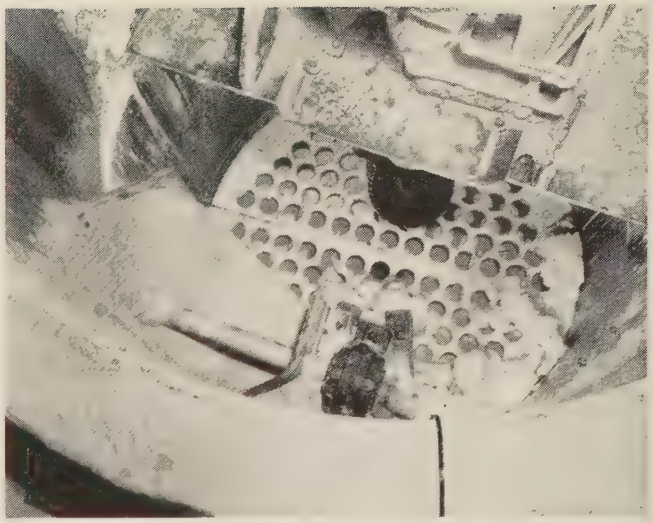

Fig. 4. Interior view of blunger

which usually gave a slip with maximum fluidity at an addition of 4 to 7 lb. per ton of clay. Other agents such as sodium hexametaphosphate, proved useful when it was necessary to slip English clays, but our use of one of the best known agents, sodium silicate, was discouraged by its narrow concentration range for maximum fluidity and its tendency to cause the slip to "liver" upon standing. With the advent of predispersed clays on the market, the question of dispersing agents has become one of minor importance.

DEVELOPMENTS IN PUMPING

Although almost any type of pump is capable of handling clay dispersions of up to 60% solids where their flow behavior is similar to that of water, considerable difficulty was encountered in finding a pump capable of handling the large volumes of 67 to 70% viscous clay slip which had to be passed through the blunger in one 16-hr. period. The main difficulty was that any high-speed pump with close tolerances subjected the liquid to high shear stresses. This would cause no difficulty in handling a Newtonian type fluid, but as it has been shown by Asdell (*2*) and Green and Weltman (*3*), deflocculated high-solids clay slips are intensely dilatant in character, becoming more and more so with increasing concentration. This flow characteristic means that under high-speed pumping very much greater torque is needed on the impeller shaft than would be required with a Newtonian liquid, and a considerable amount of the work done by the motor goes into heating up the clay slip. To add to the difficulty most of the positive action pumps cannot be used because newly slipped clay contains a high percentage of gritty lumps which would soon wear the pump parts down to uselessness.

In trying out different pumps for the job of cycling the slip through the blunger, one of the first to be installed was a 10-hp. Moyno, with a 20-hp. motor, but the V belts on this equipment burned out in 2 days. Then a centrifugal pump with $^1/_2$-in. wide shrouded blades in the impeller, rated at 1160 r.p.m. for 400 g.p.m. of water, was installed and to it were successively coupled 15, 30, and 50-hp. motors, all of which proved too small. The 50-hp. motor was just adequate for production at that time, although the pumping rate was considerably less than expected (usually amounting to only 50 g.p.m at 69.5% solids) and the pump frequently heated up alarmingly.

In order to achieve greater capacity it was decided to install a higher speed pump with wider blades and greater tolerances so as to cut down shearing stress. A class D.S. pump, rated at 200 g.p.m. of water, with a shrouded impeller having four 2-in. blades, was coupled with a 1750 r.p.m. 60-hp. motor and, since its installation it has done an excellent job, delivering

69.5% slip at a rate of 350 g.p.m. The chief fault to be found with this type of equipment is that it is not possible to utilize a water-lubricated lantern ring on the shaft, as it would cause continuous dilution of the slip, so that excessive wear is suffered on the pump shaft.

Two other types of smaller pumps have been found useful in applications where the above large delivery volumes are not necessary. A B10-10 Moyno pump with a 10-hp. drive, rated at 315 r.p.m. for 60 g.p.m. of water, has been found most useful for delivering screened clay to the coating plant. Two 5-hp. triplex plunger pumps arranged in parallel, each rated at 62 r.p.m. for 23 g.p.m. have been found quite adequate for delivering unscreened clay to the Hum-mer screen.

SCREENING DEVELOPMENTS

The most obvious problem of screening the clay slip is that of making the compromise between removing all troublesome grit and trash and obtaining a sufficient throughput of pigment to satisfy the demands of the coating plant, both without excessive capital expenditure. It is particularly important that no sharp particles of quartz or metal be allowed to enter the coating, as with our type of roller coaters they cause rapid deterioration and wear of the rubber covering on the rolls.

Since a 3 by 5-ft. inclined Hum-mer screen (electrically vibrated) had been used successfully to screen filler clay for some years, the first experiments were carried out with this equipment. It was found that if it was operated with no overflow and an occasional hosing off of rejects, a method quite successful with low density filler clay slip, the throughput of accepted 70% solids slip was too small to be practicable, especially if a 150-mesh screen were used. However, by completely covering the wire mesh with the fluid stream, catching the overflow, and returning it to unscreened storage, an acceptable throughput of screened clay was attained.

Experiments with both 100 and 200-mesh wires showed the latter to give approximately 60% of the delivery rate of the coarser screen, but the throughput of both was most strongly affected by the viscosity of the clay slip, as determined by the Stormer viscometer. Thus, slips in the 70 to 80-cp. range could be easily handled at rates up to 12,000 lb. per hr. through a 200-mesh screen, but doubling the viscosity usually reduced the delivery rate to one half.

When a new Type 38 Hum-mer screen, similar to the original, was purchased and put into production, a simple baffled headbox was at first used to distribute the flow of slip across the full face of the screen, but with the splashing and caking of clay on exposed surfaces, it was soon found that channeling occurred. Thus, it became impossible to utilize the full screening surface of the wire, which causes loss in production and uneconomically short wire life.

In order to overcome this problem and so as to present a minimum of exposed surfaces to the air, it was decided to use a perforated pipe flow-spreader at the top of the screen. The first model consisted of a $2^1/_2$-in. horizontal pipe, with a center tee connection to the main line from the pump, and a series of $^1/_4$-in. holes, drilled in $^1/_2$-in. centers along the side facing down the screen. It was soon found that the holes at the ends gradually plugged up, so the pattern of perforations was changed to two $^1/_4$ by 15-in. slots, separated at the center by a $2^1/_2$ in. space in which were drilled four $^1/_4$-in. holes. The flow from these holes served to keep the screen completely wetted down at its center. The use of this distributor, together with a change in the slope of the screen, from 23 to 17°, made it possible to keep the screen surface completely flooded and permitted substantially increased production.

Although experimentally determined throughput rates with clean screens have been as high as 12,000 lb. per hr., these rates do not apply when caking and plugging take place, so that with the old system, average screening rates over a normal week varied between 3000 and 4000 lb. per hr. (moisture-free basis). With the above-noted improvements, however, average production could be brought to 5000 to 6000 lb. per hr. In addition, screen wire life was increased from 3 to 6 mo., in spite of the increased production. The wire presently being used is standard 150-mesh stainless steel, and it is worth noting that in order to achieve full wire life, it should be tightened up in its frame two weeks after installation, and periodically inspected for proper tension afterwards.

INSTRUMENTATION

The most useful piece of instrumentation in the clay handling system is the level control for the blunger. At first, this consisted simply of a float-operated segment valve, which upon rising or falling allowed less or more slip to flow from the blunger storage into the leveling chamber. However, at frequent intervals, lumps of clay sticking in the segment valve or dried clay accumulating on the float, caused the liquid level in the blunger to rise to the point of clogging the screw conveyor or flooding the whole working area.

A more reliable control was therefore installed, consisting of an air-controlled, motor-operated 4-in. Saunders valve on the line from storage tank to level chamber, actuated by a liquid-level differential recorder and controller, connected to a bubble pipe in the level chamber. Three safety devices were installed on this apparatus, consisting of a float-operated alarm and a high-level alarm on the recorder, both sounding a horn, and a water line connected to a high-head reservoir, to close the valve in case of compressed air failure. This instrument has behaved most satisfactorily in keeping the liquid level normally within limits of plus or minus $^3/_4$ in. of the set point, thus allowing more efficient and complete dispersion of the clay.

Of lesser importance to good operation is an instrument recording slip density as per cent solids of the clay in the blunger storage. When working, this instrument is useful to new men for showing them the progress of their slipping, but because of excessive maintenance required, it is seldom considered reliable. The instrument measures and records the difference in air pressure between two bubble pipes set in the tank at a known distance one above the other, but because of the frequent emptying of the tank, clay rapidly dries in the bubble pipes and plugs them. Also, the smallest of air leaks creates a large disturbance in the instrument, leading to plugging of bubble pipes and loss of reference fluid.

A Sparling water meter is used to measure out the required amount of fresh water into the blunger storage tank for slipping.

OPTIMUM CLAY CHARACTERISTICS

With a system handling liquid clay and depending on a strict time schedule for its slipping, there are several inherent characteristics in the dry clay which are most vital to the operation of the system. Probably the most important single quality of the clay is its viscosity in slip form, which is determined on each shipment in the following manner:

A representative 650-gram portion of the clay car sample is slipped to 71% solids (estimated in a 600-ml. beaker, using a Lightnin high-speed laboratory mixer. The Stormer viscosity of the slip is determined by measuring the elapsed time for 100 rev. with a 150-gram weight, the standard hollow rotor, and the 600-ml. beaker as the container.

The slip is then diluted with water, first to an estimated solids content of 70%, then to 69%, with the Stormer viscosity being determined each time. A dispersing agent is used in this initial test only if the clay received has been dried without predispersing in which case the usual addition is 0.25% of tetrasodium pyrophosphate. By determining the actual solids content of samples of the three slips through oven drying, and by plotting the results against Stormer seconds, a curve can be obtained, from which is interpolated the viscosity at 70% solids.

Mill experience has shown that most clays with 70% slip viscosities lying between 13 and 17 sec. (150 to 260 cp.) are easy to disperse, but the few cars with viscosities of 19 sec. (280 cp.) and over, cause considerable trouble by appreciably slowing down the unloading process and reducing the maximum attainable solids content of the slip. In the event of slipping trouble being encountered early in the unloading process, operations are stopped, and a sample of dry clay is brought immediately to the laboratory. There, the effect of modifying the pH with soda ash, or of adding extra quantities of the same or different dispersing agents to the slip, is determined. If any of these additions succeed in reducing the viscosity of the laboratory slip, the required amount of chemical for that car is calculated, added to the slip in the blunger, and the unloading is continued. These measures are only of assistance when the clay is delivered without an incorporated dispersing agent, or if insufficient phosphate was added during predispersion. Usually, however, as pointed out by Millman (*4*), the high viscosity is caused by some other factor, such as particle shape or size distribution, the effect of which cannot be altered at the mill. If the viscosity cannot be reduced, the clay is added slowly to the blunger along with small additions of water, to complete the slipping of the car within the allotted 8 hr. Any clay left over is temporarily piled on the floor, to be used up with the next carload on the following day. The lower solids slip resulting from the addition of extra water (generally at 65 to 68% solids) is pumped to an empty storage tank and kept separate until it can be used up by bleeding slowly into higher solids slips.

An attractive feature added to most clays now received at the mill is the inclusion of dispersing agent in the slip before it is drum dried, which has resulted in fewer occurrences of slipping trouble, reduced dispersing agent costs, and less possibility of human error during unloading. The list of undesirable features in clay includes low density or fluffiness from any of the pulverizing processes which gives rise to clouds of dust during unloading causing high waste and objectionable working conditions. Grit in clay is naturally also objectionable as it causes considerable wear in pumps, as well as being troublesome in the coating. We have used clays with a grit content (325-mesh oversize) as high as 0.015% by weight, but the general run of Georgia clays average 0.005% by weight of grit.

The flow characteristics of our clays are checked periodically on the Hercules Hi-Shear viscometer (*5*) but it is difficult to state the observed results numerically, as no satisfactory method of mathematically interpreting dilatant pseudothixotropic rheograms has yet been proposed. However, the general impressions gained from rheograms drawn for slips at 70% solids are that the more sharply dilatant the curve, the longer the slipping time due to the pump having to work harder; and the greater the area of the thixotropic loop, as discussed by Masterman (*1*), the more trouble is encountered in slipping, possibly due to the extra energy required to break down the "body" of the fluid.

CONCLUSION

We have attempted to sketch here the system for handling coating clay and the developments leading to its installation at the Port Arthur mill of Provincial Paper Ltd., a medium-sized machine-coating mill. We make no claims for originality in design of equipment, but we do feel that the way in which it is arranged gives us the simplest and most economical system for our purposes. Thus, other mills using high solids coatings that are interested in reducing their clay handling costs or in obtaining 25% more clay storage in the same space, might do well to examine closely this or other methods of handling clay in the slip form.

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Enzyme Treatment of High-Solids Starch-Pigment Mixtures

JACK E. WILBER

The process of converting starch with a liquefying enzyme in the presence of paper coating pigments was developed a number of years ago and disclosed by Craig (*1*, *2*) in December, 1941, and May, 1942. These findings were confined at this time to the production of relatively low solids coating compositions, generally under 40%. In July, 1945, however, the same author (*3*) disclosed a process of producing operable coating compositions at a total solids content up to 72% through enzyme conversion of starch in the presence of mineral fillers and pigments. This discussion will be limited to the application of this process in preparing paper coatings at total solids falling between 58 and 65%.

The conversion of starch in the presence of pigments would appear to have several advantages over the more conventional method of coating preparation where the pigments are dispersed in water then blended mechanically with a separately converted adhesive solution. The following advantages are noteworthy: (1) lower viscosity at comparable total solids; (2) less adhesive required for comparable bonding strength; (3) generally less time required in preparation of coating compositions, and (4) improved finishing characteristics.

Along with these advantages are several apparent disadvantages including the following: (1) less versatility in selection of pigments due to their adsorption characteristics, high viscosities during conversion, and enzyme interference resulting from contaminating ions, etc.; (2) more critical raw starch specifications, and (3) lack of uniformity due to difficulty of control.

The commercial acceptance of this process by the paper coating industry has not been as rapid as might be expected. This may be attributable to its apparent disadvantages or possibly to lack of knowledge concerning its commercial application and relative merits. The development in recent years of operating know-how and techniques has served to minimize or eliminate most of the apparent disadvantages of conversion in the presence of pigment. In some instances, features that appeared to be disadvantageous have proved to be instead advantageous. This is particularly true regarding the susceptibility to control.

It seems probable that this process will gain commercial acceptance more widely once further information and knowledge are made available. The discussion that follows is a presentation of the operating variables and procedural techniques involved in high solids coating preparation as determined from laboratory, pilot plant, and commercial installations. It is emphasized here that the data and theories outlined below are believed to be accurate, but are in many cases far from complete. The process itself is relatively new and in the stage of continuous commercial development. As this development continues many advances may be ex-

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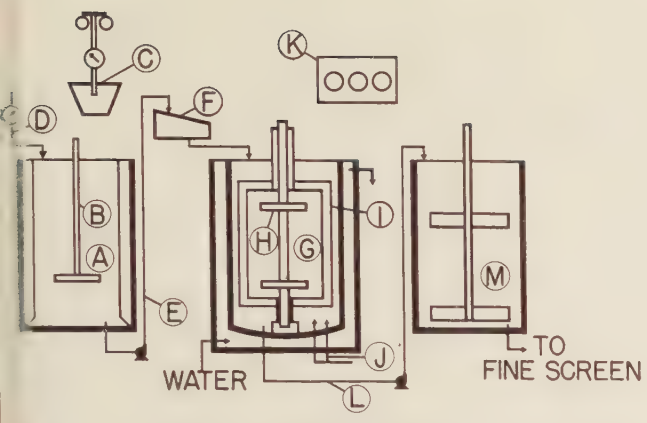

Fig. 1. Equipment layout

ted, many operating problems may be solved, and many erent advantages should become apparent.

DESCRIPTION OF EQUIPMENT

In order to follow the discussion more closely, a commercial nstallation will be described. Figure 1 is the schematic ayout of a complete unit. Much detail has been omitted ince the design and construction of individual pieces of quipment are a matter of choice. Item A at the left of Fig. 1 s a slurry mixing tank of 1200 gal. capacity. Dispersion f the starch-pigment slurry is accomplished through high-peed radial agitation B with suitable baffling. Located irectly above the slurry mixing tank and designated as em C is a weigh lorry for discharging accurately weighed mounts of starch and pigments into the slurrying tank. Water is metered through line D. The thoroughly dispersed lurry is pumped through line E to a coarse screen F and into he cooking equipment G. Thorough agitation is supplied hrough counter-rotating agitators H and I. Agitator H s of a radial type turning at relatively high speed. Agitator I is a sweep-type with scrapers actually contacting the cooker alls and turning at comparatively low speed. Heat is upplied through live steam injectors located at J. The ooker itself is jacketed to allow rapid cooling by cold water. Heat can be supplied through the use of steam in this jacket desired.

Above and to the right of the cooking equipment is the ontrol panel K consisting of temperature controllers and corders, peak viscosity meters, motor control switches, etc. he control instruments will be discussed in more detail at a ter point.

The final coating mixture is transferred from the cooker hrough line L to the unscreened storage tank M and later to itable screening equipment not shown.

Stainless steel construction is utilized throughout the stem.

GENERAL COATING PREPARATION PROCEDURE

reparing the Slurry

The slurry as referred to in this discussion comprises the gment-starch-water mixture with optimum quantities of spersing agent and alkali for pH adjustment. This slurry prepared in a somewhat conventional manner. Water d dispersing agent in the required amounts are added to e slurrying tank along with about half of the alkali required adjust pH to 7.3–7.5. The pigments are then added the tank from the weigh lorry with constant agitation. he remainder of alkali is then added. Agitation is continued til thorough dispersion is effected. Raw pearl starch is en added to the pigment-water mixture, again with con-ant agitation. When dispersion is complete, the total lids is determined by means of a calibrated hydrometer. Care is taken to always aim for the high side since corrections are easily made by simply adding water.

The final solids content of the slurry will depend upon the method of cooking, i.e., by live steam or by jacketed steam. If the former method is used solids of the slurry are generally maintained at 5 to 6% above the final coating solids desired. If the steam jacket is used, slurry solids must be maintained at a level slightly lower than the final coating solids due to loss of water by evaporation during the cooking procedure.

Following any necessary correction for total solid, the pH of the slurry is accurately determined. The initial alkali additions are invariably slightly under the optimum requirements. pH adjustments are then made by the addition of alkali in the proper amounts as indicated by correction charts previously prepared. Following a reasonable period of agitation, final pH determinations are made and viscosities recorded.

The selection of dispersing agents and alkalies for pH adjustment is extremely important. The success of the entire process is dependent upon the degree to which interfering cations (invariably present in coating clays) are effectively removed from the system and the degree to which adsorption of the enzyme by the pigments is controlled. It is necessary first to remove the interfering ions from the exchange positions (*4*) on the clay particle. This may be done through a build-up of the sodium ion concentration to a point where displacement of interfering ions is accomplished. Next these ions must be effectively removed from the system through formation of insoluble salts or complexes. In addition to this, hydroxyl ions must be furnished in excess to provide complete dispersion through preferential adsorption of OH ions or other anions that promote dispersion. All of the above conditions are met through the use of complex polyphosphates as dispersing agents and sodium silicate as alkali for pH adjustment. In addition to performing the above, these agents are buffered salts that prevent the build-up of OH ions to the extent that reflocculation occurs. Further than this, these materials provide a reservoir of OH ions that are preferentially adsorbed by the pigments during the conversion cycle, thereby preventing the harmful adsorption of enzyme with resulting erratic viscosities. The optimum concentration of dispersing agent must be determined for each particular pigment mixture. The pH, however, is invariably adjusted to the optimum activity range of the enzyme.

It has been stated that adsorption of OH ions continues during the conversion cycle. This often results in a drop of pH in spite of the buffering action of the polyphosphates and silicate. Two things may be done to aid in maintaining pH at the proper level. Some adsorption of OH ions by the pigments has been noted on prolonged standing and slow

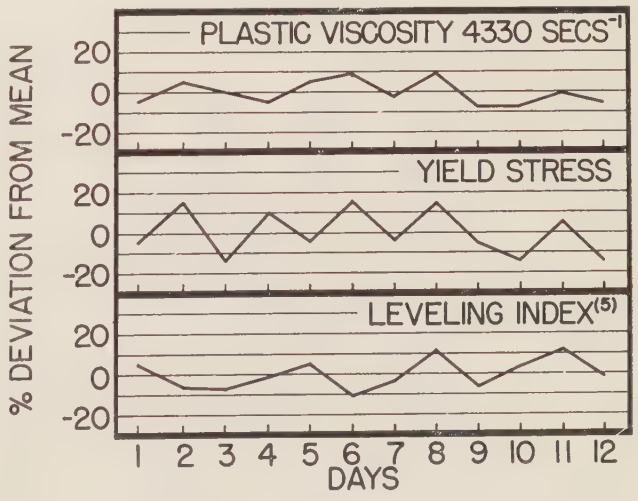

Fig. 2. Rheological data

agitation of the slurry. It is advisable therefore to prepare the slurry as far in advance as possible and then make final pH adjustments just prior to the start of conversion. The addition of as little as 5% $CaCO_3$ will also aid measurably in maintaining pH due to its buffering effect during the cooking cycle.

Conversion Cycle

Immediately following the transfer of slurry to the cooking equipment, the accurately weighed enzyme is added, agitation is started, and the steam is turned on full. The temperature of the pigment-clay mixture is raised rapidly to the gelatinization temperature of the starch used. As this temperature is approached, the steam is cut back and the cook allowed to drift to the gelatinization temperature. The point where swelling of the starch particle occurs is of utmost importance since enzymatic action affects only the ruptured particle. Gelatinization of the starch results in a rapid increase in viscosity of the cook. This sudden increase in viscosity is the best indication that gelatinization is taking place and that conversion by the enzyme has started. This point is taken as the start of the conversion period.

Gelatinization of raw pearl starch generally occurs in at least two stages. To illustrate this the case of corn pearl will be taken. The initial swelling of the starch particle in a 60% pigment-starch mixture almost invariably occurs at 154°F. barring the presence of electrolytes in the lyotropic series that adversely affect hydration. As heating continues, a secondary gel stage is reached, generally at a temperature between 160 and 162°F. It is generally agreed that gelatinization is complete at a temperature of 168°F. In order to obtain uniform reproducible results, it is necessary to bring about complete gelatinization. The manner in which this is done is a subject of much discussion. The optimum situation would seem to be one where the gelatinization is completed as rapidly as possible in order to allow uniform enzyme action on all fragments of the starch particle. In practice this procedure presents difficulty since the rapid swelling of the starch results in excessively high cook viscosities with a correspondingly high power demand and poor heat transfer within the coating mass.

To overcome these difficulties, the cooking cycle is so controlled as to bring about a stepwise swelling of the starch. The temperature of the cook is raised slowly from 154 to 160°F. When a temperature of 160°F. is attained the initial swelling stage is complete and some thinning out of the cook due to enzyme action may be noted. The temperature of the cook is then raised to 168°F. and maintained at this temperature until the desired degree of conversion is effected. The total conversion time allowed will depend upon the rheological properties desired of the final coating and the amount of enzyme used. Enzyme concentrations are generally regulated to such a level that approximately 30 min. conversion time will produce satisfactory results. Increased percentages of enzyme would produce similar results with less conversion time, but control of the process would be more difficult as will be seen later.

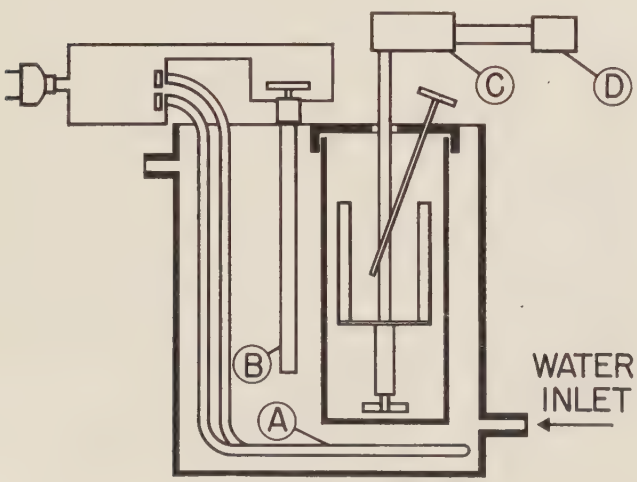

Fig. 3. Laboratory conversion equipment

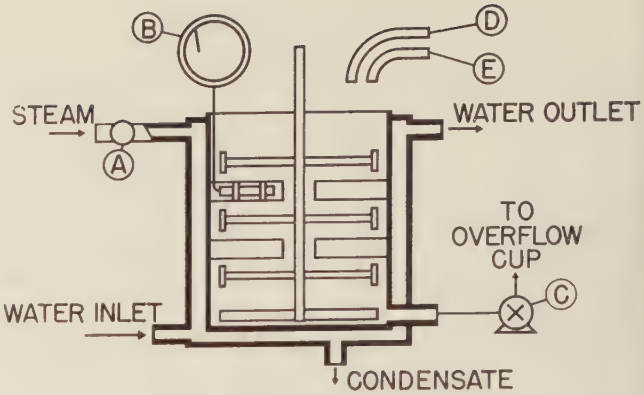

Fig. 4. Pilot conversion unit

At the end of the conversion period steam is again introduced into the coating and the temperature raised to 200°F. at a controlled rate. This temperature is maintained for a period of 15 min. to completely inactivate the enzyme. The rate of heating must be carefully controlled to obtain maximum uniformity of results. The enzyme will continue to act on the starch particle up to a temperature of 180°F. A variation in the rate of heating will logically bring about variation in the degree of conversion from batch, to batch, with resulting inconsistencies in final viscosity.

At the end of the 200°F. holding period, the temperature is lowered to 120°F. by passing cold water through the jacket. This cooling operation should be reasonably well controlled, but may vary somewhat due to changes in temperature of the water source.

The addition of plasticizers, viscosity modifiers, etc., is readily accomplished in the cooking equipment. No need for post-treatment in homogenizers, colloid mills, and the like is necessary since coatings prepared by the above procedure are of homogeneous consistency, completely free of lumps and agglomerates.

CONTROL AND MANIPULATION

Effect of Pigmentation

A number of different pigments have been used satisfactory in the process. Among these are intermediate and fine fraction domestic clays, English china clays, calcium carbonates, titanium dioxide, aluminum hydroxide, and limited quantities of calcium sulphate. While all of these pigments perform satisfactorily, each exhibit their own peculiar operating characteristics. Some show higher basic viscosities, others result in unduly high gel viscosities, varying adhesive demands, and different enzyme demands as a result of various adsorption characteristics.

In order to utilize high viscosity pigments it is generally necessary to adjust dispersing agent concentrations and increase enzyme content or extend the conversion period. These changes must be made carefully in order to avoid overconversion with a consequent loss in bonding strength. Rheological properties must also be considered in making such changes.

High gel viscosities can generally be overcome by varying the cooking cycle in such a manner that gelatinization is accomplished slowly and at a uniform rate. This will frequently necessitate a change in the total conversion time or a change in enzyme concentration.

Variation in adsorption characteristics of the different

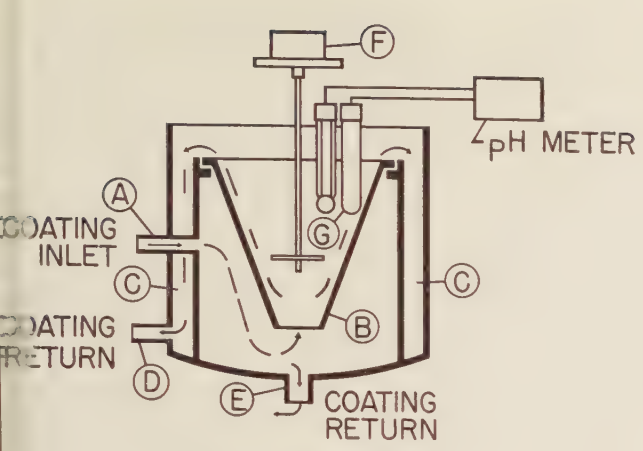

Fig. 5. Overflow cup

ig nents generally presents the greatest problem. Increased desorption or greater adsorption on heating may cause preferential adsorption of OH ions with an accompanying rop in pH. These conditions may be corrected in some ases by the addition of a slight excess of alkali and/or polyhosphate. In other cases alkali is added just prior to the elatinization point followed by the late addition of enzyme. n still other cases additional enzyme corresponding to the mount adsorbed is charged into the cook. The latter procedure is somewhat expensive and generally results in poor ontrol.

While different pigments exhibit different adhesive demands , has been found that these differences are not manifested o as great a degree in this process as in the more conventional methods of coating preparation. This is probably due o cooking and converting the starch in the presence of pigent with the resulting occlusion of individual particles by a lm of adhesive. A slight change in the percentage of adhesive will invariably correct for any change in adhesive demand ith little effect on the converting operation or on the final roperties of the coating.

The operating characteristics of different pigments must be valuated fully in the laboratory. Following such an evaluaon, these materials can be handled in such a manner as to llow uniform conversion and excellent duplication of results om batch to batch.

ffect of Starch Type

Many different starches have been satisfactorily handled the described process. Among these are corn, potato, pioca, and wheat. The selection of starch will depend upon conomic conditions and the rheological properties desired the coating. The three principal variables among starches e enzyme requirements, temperatures of gelatinization, and elatinization viscosities. Enzyme requirements are readily etermined by trial conversions in the laboratory under refully controlled conditions. Gelatinization temperares are similarly determined. A difference in gelatinizaon temperature will necessitate a change in the converon cycle in order to allow complete swelling of the starch rticle without excessive peak viscosities.

A description of laboratory equipment and testing produres is given at a later point.

ontrol in Production

Duplication of results from batch to batch is of paramount portance in producing high solids coatings for modern gh-speed machine coaters. The successful operation of ost machine coaters is dependent upon certain prescribed erating conditions and the critical rheological properties of e coating color. It is beyond the scope of this paper to scuss in detail the many factors that influence each of the significant rheological properties such as yield stress, plastic, and apparent viscosities at high rates of shear, thixotropic characteristics, etc. Be it sufficient to say that the proper operating levels can be achieved through laboratory and commercial development work. Once achieved in this manner these levels can be consistently maintained through uniform heating and cooling cycles and conversion procedures that result in a uniform degree of conversion.

Figure 2 indicates that this can and has been done. The data shown were taken from production control charts for a 2-week period. Absolute values are not shown since these will vary according to operating conditions. Shown instead are average per cent deviations above and below the mean from day to day.

The heating cycle is controlled through utilization of full scope temperature sequence regulators on the steam lines. The attainment of uniform conversion is a somewhat more difficult problem. The maximum gelatinization viscosity and the length of time that the cook remains in the gelled condition are the best indications of the ease with which conversion takes place. Viscosity during the gelatinization stage is determined through a sensitive wattmeter recording the load on the scraper arm agitator; not through absolute viscosity measurements.

Cooks that exhibit high peak viscosities and those that remain in the peak viscosity range for prolonged periods will invariably require longer conversion times than those showing low peaks of short duration. It has been possible through analysis of conversion data to establish direct relationships between peak viscosities and conversion time required. This knowledge has made possible the compilation of correction factors that may be supplied to production personnel for guidance in manipulating conversion time. This manipulation is accomplished by advancing or retarding the cam of the temperature sequence regulators. When enzyme concentrations are adjusted to such a level that the average conversion time is 30 min., excellent control is possible through the above procedure. A change in total conversion time of 20 to 30 sec. will produce a significant change in final coating color characteristics. If, however, enzyme concentrations are adjusted to a higher level with shorter conversion periods, minute changes in conversion time will alter the coating properties markedly. Such changes might easily occur through slight error in detecting the start of gelatinization. It is noted again that this point is taken as the start of the conversion period.

On rare occasions wide variations in raw materials may make it impossible to control the process by the above procedures or may require exceptionally long conversion periods.

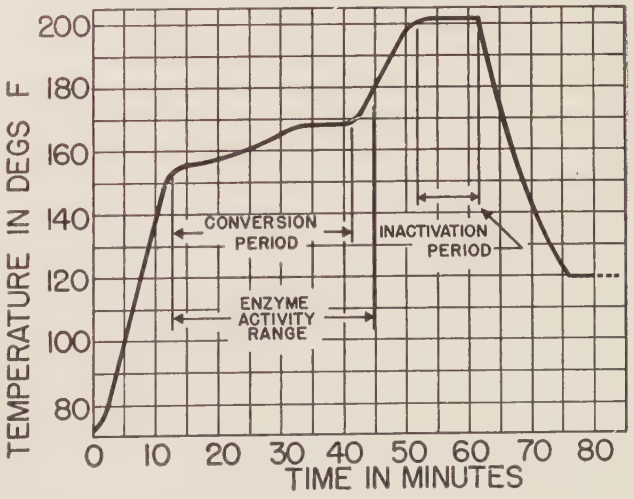

Fig. 6. Temperature versus time

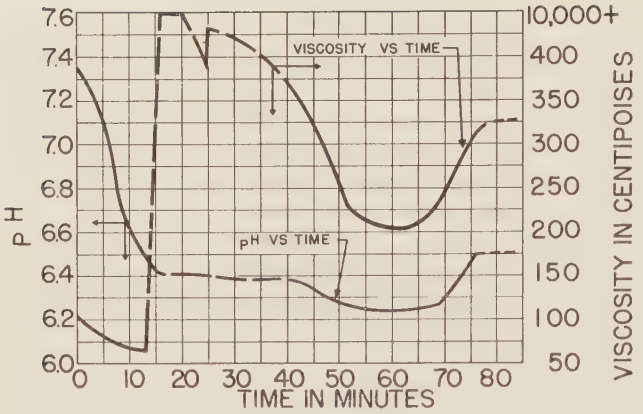

Fig. 7. Viscosity and pH versus time

In such cases, it is wise to change to alternate sources of supply and submit samples of the troublesome material to the laboratory for study and evaluation.

In spite of the above procedures, some cooks may vary slightly above or below the normal limits. When this happens, it is generally possible to alter the next cook in the opposite direction and blend it with the original. It has been found that the rheological properties of two such cooks are remarkably additive.

Much laboratory and pilot plant work has been done in developing control procedures through continuous viscosity measurements. To date this method of control has not been applied satisfactorily on a commercial scale. Inability to make measurements under controlled rate of shear at the proper level is the chief deterrent.

A continuing study of the process and methods of controlling the process give promise of completely automatic control in the future.

LABORATORY EQUIPMENT

In the routine evaluation of raw materials and in the preliminary evaluation of new materials, it is necessary to make many trial cooks under carefully controlled conditions. The determination of enzyme and dispersing agent requirements can be made readily if other variables are controlled or eliminated. Raw material variations can be prevented in the laboratory by using intimately mixed batches of standard materials and observing rigid analytical procedures in weighing and transferring these materials. The cooking temperature sequence and the rate of heating and cooling must also be controlled carefully. A change in the degree of agitation will noticeably vary the final coating characteristics and must therefore be maintained constant.

Small laboratory cookers were designed to make possible accurate control of the cooking cycle. It is also possible to change the temperature sequence in order to study gelatinization characteristics of different starches. Relative viscosities of the cook at any point in the cycle are determined through sensitive wattmeters recording power demand of the agitators.

Figure 3 is a sectional view of one such laboratory cooker. Three cookers of this type are utilized in development work. Uniform heating of water in the jacket is attained by electric immersion heaters A. The temperature sequence is adjusted manually by means of a thermoswitch B connected in series with the electric heater. Agitation is supplied by a constant speed motor C. Relative viscosities are measured by the wattmeter D. Cooling is effected by passing cold water through the jacket at constant pressure. Temperature readings of the coating itself are readily obtained from an industrial type thermometer positioned in the coating mass. Heat transfer through the stainless steel cooker walls is excellent. The temperature difference between jacket water and coating mixture is negligible except in those cases where extremely high gelatinization viscosities are encountered.

A small pilot plant cooker is shown in Fig. 4. In this equipment uniform heating is obtained with a steam jacket utilizing dry steam regulated by a high-lift valve A. Time-temperature relationships are recorded by instrument B but are controlled manually. The most interesting feature of this equipment is the installation of an overflow cup which allows continuous pH and viscosity measurements during the cooking cycle. Coating is supplied to this cup by a gear-type pump C and returns through lines D and E. The cup can be by-passed allowing continuous circulation through a closed line. The overflow cup is shown in Fig. 5.

Coating enters the cup through line A and impinges upon the outer surface of the stainless steel cone B. This arrangement prevents turbulence as the coating flows up into the inverted cone and is allowed to overflow into the outer chamber C. Line D is a return line. Rate of flow in the cup is controlled by a valve in the return line E. A Brookfield Syncro-Electric viscometer F is positioned directly above the cup. High-temperature pH electrodes are located at G.

The pilot plant equipment and overflow cup are utilized to obtain correlation between laboratory and production procedures. Extensive studies of operating variables and investigations of new material operating characteristics are possible in this equipment.

A typical conversion cycle is illustrated in Fig. 6 while viscosity and pH relationships for the same cycle are shown in Fig. 7. The coating mixture in this case consists only of starch and clay with no buffering agents except alkali and dispersing agents. The effect of primary and secondary gelatinization may be noted from the hypothetical portion of the viscosity curve, Fig. 7. (This portion of the curve is estimated from wattmeter readings since the overflow cup fails to perform satisfactorily at this stage). The effect of clay adsorption characteristics is clearly shown by the pH curve.

DISCUSSION

The enzyme conversion of starch in the presence of pigments is an efficient process for the production of high solids paper coatings. Adhesive requirements of paper coating pigments are reduced to a minimum through such treatment. The careful design and installation of equipment makes possible a coating preparation system capable of producing high solids coatings with a high degree of uniformity. Converting costs are low due to: (1) low power consumption, (2) minimum man-hours of labor, (3) elimination of post-treatment, and (4) relatively low equipment costs.

It is evident from the preceding discussions that many variables are present which must be eliminated or controlled. Extensive laboratory investigations and development work have served to reduce the operating variables to a minimum. Those remaining can be dealt with effectively in production equipment. The flexibility of the process whereby variables and conditions are controlled or altered during production is perhaps the greatest asset ascribed to the system.

The feeling may prevail that the investment in equipment is not justified for a process that is limited to the production of starch-pigment coatings only. It is noted here that the equipment described has been utilized to prepare satisfactorily, coatings containing casein, protein, preconverted starches, and other materials as adhesives. In these instances, the advantages previously noted, still prevail.

While the description and discussion of the process have been brief, the principal features and points of interest have been emphasized, with the desire to promote a greater understanding of this coating preparation system.

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Printing Ink-Paper Relationships II
Numerical Evaluation of Letterpress Print and Printing Quality

A. C. ZETTLEMOYER, J. M. FETSKO, and W. C. WALKER

Each year progress is made in developing new and better printing inks and papers, but relatively little is learned about the fundamentals that make them work together properly during the printing process. Printing inks are created to be put on paper, and most paper is made to be printed upon. Improvements in these materials themselves are not as important as how they behave when united by the printing process.

The role of the scientist in the graphic arts is unusually complex. He must delve into the age-old art of printing with ink on paper and recognize failures and progress in a systematic and objective manner so that the industry will be better equipped to effect desired improvements in printability. That advance along these lines was proceeding at a slow rate and that even empirical data were sometimes meager were recognized early and pointed out particularly by P. H. Prior (*1*) in 1938. He suggested that research on printability be concerned not only with the fundamental properties but also with experimentation which correlates with full-scale operation.

The situation is little changed today. The large number of evasive variables makes it difficult to separate and understand each individually and to relate them to the entire process. Unfortunately, the various factors are so closely interrelated that it is necessary to fall back upon printing itself as the only reliable method of studying the practical relationships of ink to paper. When an attempt is made to simplify the problem by setting up experiments in which actual printing is avoided, such results are suspect and may be of little real value. It is hoped that with further understanding the time will come when testing and evaluation can be carried out without actual printing.

An attempt is made here to review critically the large amount of scattered work which has been done on the evaluation of print quality and the printability characteristics of inks and papers. Because of the vastness of the subject, the present discussion is limited to those properties of greatest importance and to their numerical rather than purely subjective evaluation. It is hoped that this review will aid in avoiding past errors and will direct future research into those avenues which are in greatest need of development.

The discussion is divided into five main parts. The first is print quality and its various aspects, followed by the printability of paper, the printability of ink, the effects of press work, and the proposed program for future experimental work at the NPIRI.

PRINT QUALITY

It is obvious that experimentation along the lines of printability is meaningless until the end result, good print quality, is defined and objective methods of quantitative evaluation are found. Only when this objective has been accomplished can the effect of variables in paper, ink, or press be fully studied and appreciated. Although print quality is the most vital property of printed matter as far as this type of study is concerned, it is an extremely difficult term to define. Print quality is judged daily by many individuals, but its exact nature is very difficult to set down in a few words. *Print quality is the aggregate effect of the various appearance characteristics of printed matter.* How good the quality is must be determined by comparison with an appropriate standard or objective. There are a number of possibilities that have been used or suggested for this standard. Among them are the image on the plate, the original copy, and the effect which the customer has requested. The suggestion has also been made that print quality be graded in terms of psychological effect on the observer. No general agreement has been reached on these questions.

Consideration should be given, however, to the individual properties which make up print quality. These properties are most conveniently handled when they are classified into those which are of primary importance in solids and those which arise in halftone work.

Solids and Type Matter

Solids and type matter are generally characterized by appreciable stretches of continuous printed areas and readily discernible boundaries between printed and unprinted regions. For these reasons the most important appearance properties encountered in prints of this type are color, gloss, uniformity, sharpness of outline, and print-through.

Color. Color, with its great appeal to the eye, is one of the most important properties of a print. The problems of measuring color are very complex and numerous, however, as discussed recently by W. C. Walker of NPIRI (*2*). At the present time, most color matching is done by eye on the basis that it is the human eye that will be the final judge of the result. That gloss and viewing conditions also affect the appearance of a color must be recognized. Instruments for color measurement, such as the Hardy recording spectrophotometer, are available, but they are far too expensive and cumbersome for general use. Other instruments yield results which are difficult to interpret, and some are difficult to keep in operating condition. Improvements are needed in sensitivity, reliability, speed, and ease of interpretation before instrumentation will replace to an appreciable extent the use of the human eye in color matching and color specification.

Although the use of color is becoming more widespread, even in the printing of daily newspapers, black and white printing, of course, remains predominant. Black and white offer less difficulty for measurement since, ideally, black absorbs all light and white reflects all light. It is a simple matter to express black or white as a single number which depends upon the amount of light reflected. The blackness of a print is usually expressed as a ratio of the reflectance of the particular print to the reflectance of the paper.

Several instruments have been designed to measure the reflection of light from a surface. Among those available are the Photovolt reflection meter, the Hunter multipurpose reflectometer, Welch densichron, and the Zeiss-Pulfrich stepphotometer. None of these is universally satisfactory, for reproducibility depends upon operating conditions or, in one case, on settings by the human eye. Furthermore, the effect of gloss and hue often has a marked effect on the color reading obtained.

Gloss. Gloss is a psychophysical attribute of surfaces, but there is no unified concept of gloss even among experienced observers. To some, gloss may be the distinctness of mirror images seen by reflection in the surface, or it may be the contrast between highlight and nonhighlight areas, and it usually depends upon the angle of observation. It has been conceded by Hunter (*3*) that for the measurement of gloss there is no single reflection scale yielding reflection values that correlate with the glossy appearance of all surfaces. The Institute of Paper Chemistry (*4*) has made much progress in

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standardizing and modifying the Oxford glarimeter so that results correlate with the visual estimates of paper technologists. Although this instrument was designed for the gloss differentiation of white papers, it has proved to be useful in practice for the gloss comparison of printed papers. With the increasing demand for high gloss printing, it is to be expected that the measurement of gloss will become more frequently applied to printed matter.

Sharpness of Outline. Sharpness of outline is the abruptness of the color change from the print to adjacent imprinted area and the smoothness of this line of demarcation. A sharp outline tends to give printed matter a clean, crisp appearance that is a very important aspect of print quality. Although this factor has long been recognized in practical print evaluation, no attempts to evaluate sharpness of outline have been uncovered in this review of the literature.

Uniformity. Very little attention has been paid to the numerical evaluation of the uniformity of solid prints. Uniformity in solids is the evenness of the color or gloss over the printed area; mottle contributes to lack of uniformity, but uncovered areas are often more important. Unevenness of gloss is frequently encountered on hard calendared sheets where the ink absorption varies over the surface of the paper.

A method for measuring unevenness, described by Bekk (*5*), consists essentially in photographing a revolving print. The photograph is taken along the axis of rotation. The resulting print is composed of a series of diffuse light and dark rings which fade out at increasing distances from the center to a uniform density. The end point is the place at which uniform density begins. The distance of the end point to the center is the measure of nonuniformity. Interpretation of the resulting patterns is somewhat difficult and depends upon the judgment of the observer. Furthermore, the method suffers from the fundamental difficulty that a completely uniform array of light and dark areas would yield a perfectly uniform print and therefore lead to the erroneous conclusion that the solid was completely uniform.

A method described by Buchdahl (*6*) consists of photographing the print and scanning the transparent negative with a microdensitometer. The density is plotted against distance by means of an automatic recorder, and the average deviation of the points from the mean is taken as a measure of unevenness. This method is more adequate than Bekk's but it is extremely slow and tedious.

There remains a real need for an instrumental method of scanning the print directly to produce an immediate numerical evaluation of uniformity. An electronic instrument for this purpose is now under development at the Printing Ink Institute. It involves the direct microscopic scanning of a print by a photoelectric cell and the indication of the variation in the intensity of the reflected light on a meter. Thus a print of high uniformity gives a low meter reading while a highly nonuniform print gives a high reading.

Print-Through. Print-through is a darkening or discoloration of the paper on the reverse side of the print. The darkening may be produced by either of two phenomena-strike-through or show-through. Strike-through occurs when the ink vehicle penetrates through the paper as with thin vehicles, absorbent papers, or excessive printing pressures. Show-through occurs if the paper is too transparent. The transparency of paper is increased when the pores are filled with oil, and thus show-through may occur although there is no actual strike-through.

Since strike-through and show-through have the same appearance, their measurement is handled by the same techniques. The increase in darkening of the reverse side of the print, as measured with a reflection meter, has been generally used as a criterion of print-through.

Experiments by Bekk (*7, 8*) and Mill (*9*) have shown that print-through is definitely a property of the interrelationship between ink, paper, and press conditions. Previous experiments by Ant-Wuorinen (*10*) and Carlsson (*11*) dealt mainly with the behavior of one ink on several papers.

Halftones

The problems involved in the numerical evaluation of solid prints are not nearly as complex as those met when dealing with halftones. In practice, the reproduction of pictures is the most difficult and time-consuming phase of any printing process. Two characteristics of the original which must be reproduced are its tone values and contrast. A great deal of art is involved in procuring the proper contrast and tone value in both the highlights and the shadows. Often a compromise must be made in order to give the printed illustration a proportion of both. Indeed, it is a combination of skill and good fortune of the craftsmen at each stage in production if the contrast and tone correspond with that of the original. This lack of quantitative control is a handicap to efficient production since a delicate balance must be maintained through many steps from the photographing of the original down to the choice of proper printing conditions.

Tone Value. Tone value is the integrated density over a halftone area. Early research dealt mainly with theoretical considerations. The Lithographic Technical Foundation (*12*) and Yule of the Kodak Laboratories (*13*) have published excellent treatises on the relationship between dot area, dot density, and tone value. Dot area is obtained by the microscopic measurement of the actual fractional area occupied by the dots. The density of each dot and the tone value, or the integrated density of a group of dots, can readily be measured with a reflection meter. Both LTF and Yule recognize that their calculations relating dot area, dot density, and tone value are strictly accurate only for ideal halftone images consisting of dots having sharp, distinct borders and perfectly uniform densities. Unfortunately, the behavior of halftones in actual practice is far from ideal.

Buchdahl and his co-workers (*6*) were concerned with numerically measuring tone reproduction quality. Their experiments were based on the assumption that the tone values of the ideal print are identical with the tone values of the plate. Their printing plate consisted of a series of halftone blocks, a solid area, and a picture for obtaining subjective evaluations. The actual tone densities of the print, obtained by spectrophotometric measurements of brightness, are plotted against theoretical densities predicted by the corresponding halftone blocks of the plate. A curve is thus obtained which deviates markedly from the straight line which would be expected if the tone values of the print faithfully reproduced those of the plate. This deviation is the numerical measure of the quality of the tone reproduction. In the majority of cases agreement with subjective evaluation was quite good. However, Buchdahl reported that several prints which showed excellent tone reproduction according to these objective measurements were poor otherwise due to poor contrast and lack of uniformity. He suggests that a combination of objective methods would necessarily be the best procedure in numerically determining print quality.

Poulter and Croney (*14*) of the PATRA staff in England were also concerned with a numerical determination of halftone print quality. Like Buchdahl, they attempted to achieve their evaluation by measuring tone reproduction. Extensive experiments on halftone reproduction were performed by Berberich and co-workers (*15*) and Larocque (*16*), but their criterion of print quality rested upon the opinion of several qualified observers.

Contrast. Contrast is the sharpness of detail. Bekk (*7, 8*) was concerned with an experimental method for predicting the best contrast which could be obtained from a given paper-ink combination. He devised a special halftone plate with a continuous gray scale background. Superimposed on this background is a series of lines the dot area of which corresponds to

st of the dark end of the gray scale. Thus the lines at one d of the plate stand out clearly from the background while se at the other end tend to disappear into it. When prints re made from this plate, the number of lines which can be ea lily distinguished is a numerical measure of the contrast tained. Bekk recognized that evaluation of image reduction according to this method leaves much to be desired. Since it is impossible to obtain two plates exactly like through the etching process, the results could not be reproduced. Furthermore, the determination of the end point yond which the lines cannot be discerned is a matter of man judgment.

Consideration must also be given to the matter of the exact ape of the individual dots. Edges may be irregular, or a ushing out of the ink may produce doughnut-shaped dots. kk (*8*), Poulter and Croney (*14*), and Bernstein (*17*) have mined dot shapes by photomicrographic methods. There no means available for numerically evaluating these dot ciencies.

It is indeed unfortunate that so important an aspect of print ity as halftone reproduction remains largely a matter of ubjective evaluation.

THE PRINTABILITY OF PAPER

It is recognized that the most important test of a paper or is its performance in its end use, or the print quality it pro- es under practical printing conditions. Attention must be i, therefore, to the variables which lead to good print lity so that improvements may be made intelligently ing the manufacturing process. This is particularly true of aper, because after paper is made, there is no known method f greatly altering its printing quality. Printing inks, on ne other hand, have more latitude in that they can be altered r adjusted, within limits, to suit the paper and the press.

In the past 20 years, a great deal of effort has been put rth on the part of papermakers to devise tests which will eck a paper for printability at the time of manufacture. he ideal test would be simple and rapid, free from human rror, and would correlate with printing results. The fulllment of this task is no small matter, for a large number of ariables contribute to the suitability of paper for printing. antrowitz (*18*) of the U. S. Government Printing Office onsiders that the tests for the evaluation of paper properties om the standpoint of the printer may be grouped into three ajor classifications: (1) physical tests for determining urability, (2) chemical tests for evaluating permanence, and 3) tests for evaluating the printing properties. It is with ne latter that we are concerned here. Although the printbility of paper is dependent on a variety of properties, it is enerally conceded that smoothness under printing pressure, k receptivity, and surface bonding strength rank as the most portant.

moothness

Smoothness is the facility of a paper to make close contact ith a printing surface under the influence of the printing pressure. Rough papers require more ink to fill the "valleys" so at the likelihood of unevenness, print-through, and poor alftone dot formation is increased. Perfect smoothness is ot essential if the paper possesses a certain degree of softness that it may be successfully compressed to a smooth surface uring printing. Larocque (*19*) has shown that if a group of apers has the same smoothness when uncompressed, those hich are the softer will have the better printability. Larocue (*20*) has also stated that no single test available today ttisfactorily measures printing smoothness but that a comnation of smoothness and softness would give a better incation of the finish than either test alone.

Two general types of measurements, air flow and optical, ave been used to measure the smoothness of paper under pressure. The air flow techniques involve pressing the paper gainst a flat surface and measuring the time required for a given quantity of air to flow between them under specific conditions. The smoother the paper the better it will conform to the surface and the more time will be required for the air to pass through. A method of this type was devised by Bekk (*21*) which involves contact between the paper and a glass plate. The usefulness of this method was confirmed by the work of Wehmhoff and co-workers (*22*). The Williams method (*23*) measures the time for the passage of 25 cc. of air over two surfaces of the sample, and the Gurley-Hill S-P-S method (*24*) requires 50 cc. to pass between tight test surfaces. Bendsten (*25*), on the other hand, devised a roughness tester in which the air is passed under a narrow edge, into the recesses on one side of the sample, and up on the other side. Beazley (*26*) modified this method so that the smoothness was measured under pressures comparable to those found in actual printing. The Bekk, Gurley-Hill, and Williams smoothness testers were suggested as the most suitable methods by the Graphic Arts Committee of TAPPI (*27*) in 1948. The inherent difficulty in air flow methods of smoothness determination is the fact that air can pass through the body of the paper as well as through the spaces between the paper and the surface pressed against it.

An optical method of smoothness measurement has been devised by Chapman (*28*). This method is based on the use of a glass prism which is pressed against the paper to be tested. The prism is illuminated, and the intensities of the light diffusely and specularly reflected from its lower face are measured. The ratio of these quantities is dependent upon the fraction of the lower face which is in contact with the paper. The method has the advantages of being made under pressure, of really examining the conformity of the paper to a flat surface, and of allowing the operator to view the distribution of noncontacting areas.

The optical method has two serious disadvantages, however. First, in printing the paper need only come close enough to take the plate to contact the ink film on it. An attempt has been made to take this factor into consideration by using the prism with a film of transparent liquid on its lower face. The second difficulty is a matter of the time factor. Measurements are made slowly so that the paper is in equilibrium with the compressing forces while in printing the force is applied for only a fraction of a second.

A review of the testing of paper smoothness leaves one with the feeling that perhaps a better answer might be obtained by the examination of a solid print made on the paper under very carefully standardized printing conditions. A very smooth paper would make very good contact with the plate, and the print made on it would show very little uninked area. An uneven sheet, on the other hand, would produce a relatively poorly covered print. Certainly a test of this type would have the best possible chance of correlating well with press results.

Ink Receptivity

Ink receptivity has been defined in a number of ways. The definition proposed by ASTM Committee D-6 (*29*) is that the ink receptivity of a paper is its ready capacity to accept the transfer of inks from printing surfaces. Kantrowitz (*18*) defines ink receptivity as that property of a sheet of paper which causes it to absorb ink. In the majority of letterpress processes ink receptivity is associated with rate of oil absorption, and therefore an extensive effort has been made to find a method for measuring oil absorption which will correlate with press results.

In order to impart a better appreciation of the complexity of the problem, let us analyze the printing process. Under the influence of the printing pressure, ink is transferred from the printing surface to the paper and is forced between the upper layers of the paper fibers or coating. The composition of the ink is continually changing due to vehicle penetration, and any portion is seldom the same composition as the ink

which was transferred from the plate. Research on the problem of measuring the oil absorption of paper may be conveniently divided into four categories: fundamental research, absorption of oil, absorption of oil from inks, and absorption of oil from printed inks. It must be understood that none of these methods should be overlooked, for each may be considered a link in the final understanding of the problem. Conclusions based on studies of the absorption of oil alone must be viewed as tentative and inconclusive.

There have been many investigations into fundamental theories related to the nature of the action of liquids in porous media. The work of Tollenaar (*30*) is of the most interest to us because it is concerned directly with the structure of paper. He proposed that it is not the average pore size which is the most important in capillary rise of liquids in paper but the distribution and number of the most frequently occurring pore sizes and the pore sizes which transport the greatest amount of liquid. He also brought out the manner in which the coating of paper gives it a double structure with two independent systems of capillaries. Although of great theoretical interest, Tollenaar's structure constants can find no immediate practical value since the pore distribution through paper is different than that along paper which he studied, and since the effect of the pigment in printed films cannot be neglected.

Reed (*31*) was the first to attempt measurement of the absorption of oil into paper. In his oil drop test, an oil drop of fixed volume is dropped onto the paper surface, and the time for penetration through the sheet is noted. His oil-flotation test requires observation of the time for permeation of the paper when floated on oil. Both tests suffer because they require visual observation of the end point and much more oil than would come from an ink film. Grantham and Ore (*32*) described a method similar to Reed's oil drop test. Larocque (*33*) measured the change in light transmission following an application of a thin film of oil to the paper. This method was found to lack reproducibility when investigated more thoroughly by The Institute of Paper Chemistry (*34*). Vallandigham (*35, 36*) developed a photo electric absorption meter, called a Vancometer, which measures the change in specular gloss when a thin film of standard oil is applied to paper by a standard procedure and allowed to penetrate. It is claimed that this method yields fairly reproducible results. ANPA (*37*) estimated penetration rate from the depth reached by a viscous oil in 20 sec. The experiments of Ant-Wuorinen (*10*) led him to the conclusion that the behavior of paper toward oil is so different from that toward ink that it is not advisable to draw direct conclusions regarding the printability of a paper from its behavior toward oil. Furthermore, in actual printing practice paper is never completely soaked with oil as it is in most of these oil absorption tests.

The ink absorbency test of Dodge and Tarvin (*38*) involved setting the paper in a pool of ink and measuring the time for the reflectance of the reverse side to fall a given fraction of its initial value. Voet and Brand (*39*) used the same procedure but their measurements included the rate of change of reflectance with time. Neither of these methods is completely valid since they depend on the penetration of the ink completely through the paper at least until the reflected light is affected. ANPA (*40*) described a procedure for rolling a cylinder covered with the test paper over a drop of ink and evaluating ink receptivity from the size and shape of the pattern formed. It was found, however, that the spreading was dependent also on the smoothness of the test sample.

A number of workers have developed methods for following ink absorption from printed films. Bekk (*7, 41*) devised a scheme for printing a thick film of ink on a sheet of paper and blotting the excess at certain time intervals. The amount of ink remaining on the paper, determined gravimetrically, is a measure of its absorbability. The plot of ink absorbed versus time shows that the absorption process takes place in two phases: the initial ink adhesion and the further penetration with time. Bekk believed that irregularities in his data were caused by air trapped in the paper. Although the method shows considerable merit it also has several disadvantages; the material removed may be richer in pigment than was the original ink, weighing of the paper is too great a source of error, and the amount of ink applied is far more than that encountered in printing practice. More recent investigators determine ink absorbency from loss of prints made on printing presses. Frost and Reynolds (*42*) visually determined the time for complete disappearance of gloss, while Vallandigham (*35*) and Bowles and Silcox (*43*) measured with photoelectric cells the loss in gloss of the print with time. Vallandigham pointed out that the time of initial breakthrough of the oil into the sheet is the critical instant for surface evaluation and that evaluating the sheet by total time of absorption is of little use. In a similar manner Bowles characterized the absorbency of the paper with reference to three constants: initial penetration, when the filtration of the oil is rapid because of the applied printing pressure; rate of absorption as filtration takes place without external pressure; and residual reflectance when filtration ceases. The work of Vallandigham and Bowles is considered to be the most useful to date. Their methods are nevertheless in need of refinement, particularly in the direction of modifying the technique to enable reflectance measurements during the vital 10-sec. period just after the time of printing.

Rate of oil absorption is becoming more important because of the increase in types of prints desired. For good gloss a paper with low ink absorbency is needed so that most of the gloss vehicle remains on the top of the sheet. A highly absorbent sheet tends to produce a flat print with relative freedom from mottle. The absorbency of the paper also affects the type of ink needed for fine halftone work.

Surface Bonding Strength

The surface bonding strength of a paper, sometimes called its pick resistance, is the resistance to separation of coating or fibers or to cleavage parallel to the sheet surface. Picking may be caused by weakness of the coating material or by the use of an excessively tacky ink. Numerical tests for evaluating surface bonding strength of paper have become essential since the development of multicolor and high-speed printing.

Early attempts to measure pick resistance involved applying a series of waxes of known cohesive strengths to the paper and noting which wax failed to remove any of the surface when pulled away. Series of waxes of this type have been developed by the K and N Laboratories (*44*) and the Dennison Co., and TAPPI (*45*) is attempting to standardize the manner of using these waxes.

In the early 1930's, Bekk (*46*) proposed an instrument to give pick resistance a numerical evaluation. The Bekk method measures the force required to detach a definite area from a strip of paper which has been fastened with molten shellac to a flat piece of metal. Although this method is useful for comparative purposes, the conditions of the test are not the same as those met in actual practice where only a small area of the surface is removed.

The newer instruments involve methods of testing which come very close to duplicating actual press conditions. Instruments designed by The Institute of Paper Chemistry (*47*) and the Research Institute for the Graphic and Allied Industries of the Netherlands (*48*) consist of an inking cylinder in contact with a cylinder carrying the paper test strip. During each test the speed of printing varies from zero to a maximum value. Picking is observed at a particular distance after starting and thus at a known speed.

The Hercules Print Tester (*49*) is similar in operation to these two. The two principal differences are that there is an additional inking cylinder which allows testing the ink in a worked condition and that each test is run at a constant velocity. Constant speed necessitates more runs in order to de-

ce: mine the velocity at which picking occurs, but more nearly corresponds to press operation.

The Lithographic Technical Foundation (*50*) tests picking using a hammer and anvil principle. The hammer is mounted on the circumference of a cylinder and is coated with the ink. The anvil is in a fixed position and holds the test paper. The hammer is spring loaded so that upon striking the anvil compression and subsequent recoil take place. The pick strength is measured in terms of the softest tack-tested ink which will pick the paper.

These pick testing instruments are also of interest because they may be useful in the testing of printing inks for picking tendency or tack. In such tests it is important that the ink be agitated or applied just before printing to make sure that the structure of the ink is broken down as it is on a printing press.

This recent development of a variety of instruments to measure surface bonding strength of paper is encouraging. These instruments should be studied carefully to determine their relative merits and demerits. After the necessary improvements have been made, steps should be taken for standardization for use in both the paper and ink industry.

PRINTABILITY OF PRINTING INKS

Printing inks and their properties hold a very vital position in the combination of factors which determine the print quality obtained on a particular job. The ink is normally the last material to be selected, and it is formulated to produce the effect which is sought on the chosen paper stock with the printing equipment at hand. Thus it is the final link that ties the other factors together into a compatible combination for the production of the job. Furthermore, if any adjustments are found to be necessary after production has started, it is the ink which is most readily adapted to change.

In spite of recent advances, improved formulation of printing ink is still essentially an art because of the lack of objective methods of evaluating its properties. Printing inks are composed of two basic elements, vehicles and pigments, and proper selection and combination of these materials determine the printability of an ink. Printing ink properties of importance to printability can be divided into two main categories: working properties and optical properties.

Working Properties

The working properties of an ink are of prime importance in successful printing for they determine how the ink will travel from the fountain, be distributed on the rollers, transfer to the plate and thence to the paper. Further, they determine to a great extent the uniformity or "lay" of the ink on both solids and halftones. The analysis of the behavior of ink through these processes is indeed difficult for the working properties of ink in any one of these steps is a combination of at least four factors which are closely interrelated and fundamentally not well understood, i.e., viscosity, thixotropy, tack, and length. These matters have been discussed in considerable detail in NPIRI Project Report No. 15, "The Rheology of Printing Inks I. An Introductory Survey."

Viscosity. Viscosity may be most simply defined as resistance to flow. Its numerical evaluation is relatively straightforward in the case of simple liquids such as most oils and solutions. In these cases the viscosity has a single value, and the flow is said to be Newtonian. The flow behavior of most printing inks is more complicated, however, since the usual or apparent viscosity decreases with increasing rate of shear; such materials are said to be thixotropic. In this case the flow properties can be more completely characterized by the plastic viscosity and the yield value. As the rate of shear is increased, the corresponding increases in shearing force have been found to become directly proportional to the increases in shear rates. The ratio of the force increases to the rate increases is known as the plastic viscosity. The yield value is the shearing force which would be required to produce the first movement.

A very considerable amount of work has been done by Buchdahl (*51*), Green (*52*), Zettlemoyer and Lower (*53*), and others on the determination of the viscosity and thixotropic characteristics of printing inks in the rotational viscometer. This work has been undertaken to provide a fundamentally sound basis for the understanding of the working properties of printing inks. The studies have contributed much to our knowledge of the flow of non-Newtonian systems, but to date the correlation between rotational viscometer data and the action of inks in the printing process is obscured by differences in the types of action involved.

Recently, attention has been directed to the elastic properties of inks. Sjodahl (*54*) has taken high-speed pictures of the action of inks at the nip between rollers. These pictures indicate that ink splitting takes place as a necking down of many fine threads. Both Voet (*55*) and Hull (*56*) have started to explore the importance of the viscoelastic properties, but final conclusions have not been reached and practical procedures for estimating elastic contributions have not been realized. As indicated below, inkmakers must still rely on measurements of the more complex but realistic property called "tack."

Buchdahl (*57*) has made a start at interpreting the working properties of inks in terms of rheological characteristics as measured in a rotational viscometer. Viscosity at low rates of shear determines the behavior of the ink in the fountain and at high rates of shear the transfer from roller to roller and thence to the plate and the paper.

Thixotropy. Thixotropy, the tendency of the ink to become fluid when agitated and to become rigid at rest, is essential for successful letterpress printing, as is pointed out by Bowles (*58*). The ink after being transferred to the printing form must resume a rigid structure so that it does not flow to the adjacent unprinted areas on the plate. Similarly, after it is transferred to the paper and the vehicle components penetrate into the paper, the ink rich in pigment remaining on the surface of the print becomes more thixotropic and hastens ink setting. This setting action leads to sharper impressions and less set-off. Bowles (*59*) has described an apparatus which measures the build-up of the structure of an ink as the shear is decreased rapidly within a given time.

Tack. The degree of tack of an ink, or the resistance to splitting of an ink film between two separating surfaces, is of vital importance at the moment of impression as it controls picking of paper and trapping of colors. The Inkometer, an instrument developed by Reed of the Lithographic Technical Foundation (*60*) is the most widely used instrument for the evaluation of tack although many others have been proposed. This instrument consists essentially of three rollers on which the ink under test is distributed in the same way that it is on the distribution system of a printing press. The instrument is designed to measure one of the components of the force required to split the ink film as it leaves the nip between two of the rollers. Thus on the Inkometer the ink is being tested under conditions very similar to those it will encounter in actual use. It is for this reason, because it has been found to produce reasonably good correlation with press results and because the readings can be obtained very quickly, that the Inkometer is so widely used today.

The original method for the determination of tack is the manual tap-out test. Here a small quantity of ink is distributed over an area of hard bond paper by a tapping action of the tester's finger. When the film has been worked down to printing thickness, the resistance of the ink to a sharp pulling up of the finger is noted. Of course, this technique does not produce a numerical result and is highly subject to the personal judgment of the tester.

An attempt was made by Green (*53, 61*) to overcome the shortcomings of the tap-out method by the development of an analogous mechanical instrument. The Green tackmeter is

essentially a mechanical finger which measures the force required to split an ink film under it. This instrument measures viscosity rather than tack and is not widely used because the films used are much too thick, the structure of the ink is is not thoroughly broken down at the moment of test, and the separation rate is too slow.

The inclined plane tackmeter described recently by Voet (*52*) has aroused considerable interest. This instrument consists essentially of a cylinder rolling on a V-shaped track. The cylinder covered with paper rolls down the track on one side, over an inked plate and up the incline on the other side. The energy of the rolling cylinder is measured by the height to which it rises on the second slope. The energy lost by the cylinder in passing over the inked plate can be measured and is presumably that involved in the transfer and split of an ink film. This instrument is primarily of theoretical significance because of the difficulty of the experimental technique and because its printing conditions do not resemble closely those found in practice.

Length. Length is a working property of printing inks which is observed at low rates of shear. It is generally defined as the ability of an ink to be drawn out into a thread and is evaluated by attempting this action manually. No instruments are available for the measure of length, but it is known to be related to the flow of an ink down an incline and to its yield value or thixotropy

Optical Properties

The optical properties of an ink include its color, transparency, and covering power. These properties govern to a great extent the color characteristics of the printed film and the amount of ink that will be needed.

Color. The color includes two factors, the color of the bulk ink and the color of thin films of the ink. The latter one, the so-called "undertone," is the only one of real significance in printing. As a matter of fact it has been demonstrated by Bekk (*62*) that the relative color of two bulk inks in some cases may be completely reversed when they are printed on the same paper. Color matching of inks to give the effects desired is a fine art in itself which cannot be covered by the present paper.

Transparency. The transparency of an ink, or its ability to transmit light to and from the paper under it, is very important in the achievement of various effects in printing. It is a factor which is not normally measured objectively but is evaluated by the visual examination of prints.

In printing inks, in contrast to paints, transparency is frequently a highly desirable property. In colored prints there is seldom any attempt to hide the underlying surface completely. Instead the objective is primarily to modify the color characteristics of the light which passes through the ink film, is reflected from the background, and returns through the film. In multicolor printing, ink films are frequently intended to show through an overlying film. Under these conditions transparency is very important to the cleanness and sharpness of the result.

Covering Power. The covering power of an ink on a particular paper is usually expressed as its mileage, or the area of paper covered by a unit weight of ink. For many reasons such as speed of drying, decrease in offsetting, excellence of print quality, and economy, it is desirable that the production of the desired color of the print be accomplished at a minimum film thickness. The coverage of ink on papers, therefore, has been the subject for a great deal of investigation on the part of both the ink maker and the printer. The usual procedure has been to measure the increase in color with increasing quantities of ink applied to the paper. The color of the film of ink is measured with a reflectance meter, but the manner of measuring the weight of ink has varied widely.

Many workers, among them Bekk in Germany (*7*, *8*, *62*), Mill and Colquhoun of PATRA in England (*63*), and Laroque and co-workers in the United States (*16*), reported weighing a thin inked copper plate before and after printing. Measurements by this method have proved satisfactory, but the validity of this approach is questionable because the print is made from ink at rest. In actual printing practice prints are made from ink films which have been broken down during their distribution and have been given little opportunity for structural build-up. Simple, direct weighing of the paper before and after printing is hampered by unpredictable errors from variations in paper weight due to absorption or loss of water vapor. A technique for weighing the paper in a moisture-conditioned box was developed at the Institute (*64*). This method, though it produces satisfactory precision, is slow and inconvenient.

With a view to avoiding the weighing of the paper on the plate, Buchdahl (*65*) has presented two methods. One involves the use of radioactive tracers in the ink and the estimation of the amount in the ink film by means of a Geiger-Muller counter. This method is somewhat hazardous since a hard ray emanator must be used to obtain sufficient sensitivity, and it is also inconvenient because calibration curves must be determined frequently because of decay of the radioactive substance. His second method employs dye tracers such as methyl violet which can be extracted from the print and determined colorimetrically. The dyestuff method possesses many advantages, among which is the fact that the determination need not be made immediately. Care must be taken, however, that no materials are present in the ink which will produce turbidity or a shift in the absorption spectrum.

In general, very good correlation exists between the mileage of the ink on a particular paper and the print quality of both the solids and halftones. This finding is not difficult to understand. If great depth of color is produced at a low film thickness, chances are diminished for set-off, strike-through, mottling of solids, and squashing out of halftones. Because of the relative speed with which blackness and ink film thickness can be determined for solid prints, this direct method of measuring mileage may well be used as a control test in paper production and in ink production. It must be emphasized, however, that one should never refer to the print quality obtained from a specific ink or from a specific paper, but from a specific ink-paper combination.

Other Ink Properties

There are other ink properties that are of importance to printing quality, particularly in special cases. Two of these properties are of general enough interest to be taken up here, however.

Degree of Dispersion. The degree of dispersion of the pigment in the vehicle is a basic factor which affects all the printing properties of an ink. Most of these properties are dependent upon the mean pigment particle size, but the tendency of an ink to fill fine screens is dependent primarily on the number and size of the coarsest particles present. This important quantity can be measured with the NPIRI production grindometer (*66*) and related instruments.

Glossing Tendency. Although the gloss obtained on a particular print is a function of paper properties and printing and drying conditions, there is a marked difference between the gloss developing tendencies of various inks. This difference is introduced intentionally by modification of the vehicle to produce the desired amount of gloss on the paper stock to be used. The only known method for the evaluation of this property of inks is experimental printing.

PRESS WORK

The best ink and the finest sheet of paper will not produce a quality print if techniques in handling them on the press are faulty. It is useless to insist upon smooth, uniform paper, for example, if the impression plate is imperfect; and an ink with exceptionally good working and optical properties will be put

o disadvantage if too much ink is carried or if the printing ressures are excessive. Quality printing depends to a large xtent on a craftsman's skill in manipulating the paper, ink, nd press. It would indeed be a big step forward if it were ossible to evaluate numerically some press variables, es- ecially pressure and makeready, so that they could be con- rolled on a scientific basis.

rinting Pressure

Since the print quality of both solids and halftones is known o be highly sensitive to the pressure used during printing, the ontrol and knowledge of the magnitude of this variable are ery important in printing. If the pressure is too low poor ransfer of the ink may occur. On the other hand pressures hich are too high may result in embossing of the paper, wear nd damage to the plate, and distortion of the print especially here halftones are concerned.

It seems apparent that much of the research previously ade on printing suffers from a lack of exact knowledge of the rinting pressures involved. Work done without a thorough nowledge of the effect of a variety of known pressure condi- ions may add to the art of printing and formulating ink and aper, but it can do little to help put these processes on a ound scientific basis.

Prior (*67*) is one of the few who stated that experiments on rintability are less meaningful without the knowledge and ontrol of printing pressure. He varied the pressures in his xperiments by changing the number of sheets in the packing f the cylinder and measured it by observing the flattening of ax pellets. This system had been previously calibrated with Mullen burst tester. Prior estimated that the error in- olved in this method of measuring printing pressure may ave amounted to as much as 50%. On the other hand, the der of magnitude of pressures used was known, and his ex- eriments showed that about twice as much pressure was eeded to print satisfactorily on art paper as on newsprint.

A method for measuring printing pressures which employs he use of a strain gage incorporated in the printing block as developed at PATRA (*68*). The electrical resistance of he gage varies with the pressure applied and is measured on a athode ray oscillograph. The pressure corresponding to the esistance change is obtained by static calibration. Poulter nd Croney (*14*) used this arrangement for their experiments the printing of halftones. They experienced considerable ifficulty and delay because the pressure-sensitive element was ot stable and had to be calibrated frequently. Their ex- eriments proved conclusively, however, that pressure is a tal factor contributing to the print quality of halftone re- oductions especially in the light tones.

Croney (*69*) investigated more thoroughly the manner in hich pressure varies with the size and shape of the printed pe character. His technique consisted of loading individual aracters with known weights and measuring the amount of netration into a packing. The results of his simple ex- riments showed that vastly more pressure is exerted on the naller characters and that the edge of a character receives ore pressure than the center. Croney's findings correlate th those found in actual printing practice where the small- halftone dots have the greatest tendency to be squashed t to form doughnut shapes.

Another instrument designed for measuring printing pres- res is the Huck pressure-sensitive base used by Larocque 3) in his experiments. It consists of a bridgelike structure stainless steel which deflects under pressure. The deflec- n is amplified 15-fold by means of an arm, and the resulting tion is read on a dial indicator which has been calibrated to d directly in printing pressure in pounds per linear inch. though this instrument has been found to be satisfactory for proximate measurements, it is slightly inconvenient to use ce the dial indicator must be removed before actual print- ; can take place. The pressure reading is also made under static rather than dynamic conditions and must be separately calibrated for various areas of the plate.

Other workers who were not equipped with pressure-reading instruments at least took some precautions to keep the printing pressures reasonably constant. For example, Weymouth (*70*) printed paper samples of different calipers at the same pressure by backing a sheet of one with sheets of the others. This method is satisfactory for comparative studies if the same general type of paper is used throughout. Exact knowledge of printing pressure is required if a variety of papers is to be investigated, since the pressure for the development of optimum print quality varies from one type of paper to another.

Makeready

Makeready is the process of making localized pressure adjustments so that the plate will produce a more uniform impression. The importance of proper makeready, even with a precision-made plate, cannot be overemphasized especially in the printing of halftone reproductions. The various dot sizes of a halftone plate do not receive the same pressure, and this difference must be compensated by bringing up the solid areas and shadows.

The process of makeready is usually a manual one and involves increasing or diminishing the height of certain areas of the plate or the impression cylinder until a uniform impression is obtained. Since many proofs must be taken, makeready becomes tedious and time-consuming. Probably no two printers in the country make a plate ready in the same manner.

The use of soft backings or rubber plates minimize the amount of makeready needed. On the other hand, hard backings produce sharper, cleaner prints; and rubber plates do not have sufficient dimensional stability for many types of work.

A radically different type of makeready, or really pre-makeready, was proposed by Letouzey (*71*), a Frenchman. It has been shown that different types of characters and outlines require different printing pressures according to the actual area of the character itself. Letouzey adjusts these printing pressures by a predetermined variation in the height of each character. The distribution of pressure of the form can be checked with a special carbon paper which is sensitive to small changes in pressure. The Letouzey process is particularly suited to printing from linotype or monotype on flat bed presses. When it is properly used, comparatively light pressure is needed for printing, and the print quality is generally high. Although this method is in commercial use in a few plants abroad, it has definite limitations. The calculation for the relative height of characters is based on a particular height and kind of packing and is only roughly applicable to others. To date, it has not become practical to apply it to stereotypes, rotary presses, or halftone work.

There are other pre-makeready systems, such as the Bishop and Medal processes, which are used to an extent in commercial work in this country. The important point to be made here, however, is that in most cases printing pressure is not a simple, single-valued variable, but is usually a factor with considerable local variation over the printing plate. This local variation and its control are vital to high quality printing.

PROPOSED PROGRAM FOR FUTURE RESEARCH

It is evident that further knowledge of the critical steps of the printing process should lead to a more intelligent formulation of printing inks and paper surfaces. The Printing Ink Institute, concerned primarily with improvements in ink formulations, has embarked on a study of printability and related phenomena. It was recognized early that methods and instruments must be developed first for the numerical evaluation of several aspects of print quality so that the effects of ink variables can be studied in a more scientific manner.

It was further recognized that there are a great many variables and properties to be controlled and measured in such a study and that the simplest situations must be understood before it is feasible to proceed. It was planned, therefore, that the printing of solids should be the first field to be studied. When the printing of solids is fairly well understood, it will be reasonable to proceed to a study of uniform halftones and finally to mixed halftones. With this type of an approach it should be possible to proceed without losing control of any of the important variables. Furthermore, the printing of highly opaque black ink should be considerably simpler than the use of colors.

The initial work was done by Zettlemoyer, Eckhart, and Walker (*64*) on the printing of black solids on various paper stocks using a Vandercook No. 4 proof press. Measurements were made of the blackness of prints on particular paper stocks as a function of the thickness of the printed film. This work resulted in a method for finding ink film thickness by weighing the paper before and after printing in a moisture-conditioned box. Experiments intended to check the precision of Buchdahl's dye tracer method (*65*) for determining ink film thickness showed that this method was also quite satisfactory. It was further found that a logarithmic function of the reflectance of the black solids plotted against film thickness gives a straight line relationship. Previous workers, including Bekk (*62*) and Mill (*63*), had found that a curve is produced by plotting the reflectance itself against film thickness.

Extension of the work on the printing of solids at the Printing Ink Institute will be resumed after techniques have been worked out for the measurement of printing pressure and the nonuniformity of solid prints. A pressure-sensitive base similar to that used by Larocque (*16*) is now at hand for the pressure measurements, and, as previously mentioned, a new electronic instrument called the "Printegrator" is under development by Walker and Bibolet for the measurement of the quality of solids. With these additional measurements it should be possible to develop a more complete and reliable picture of the printing of solids.

After a thorough knowledge of solids has been obtained, the work will be extended to include halftones. In the printing of halftones, however, pressure is even more critical since it has a marked effect on the distortion of the dots and thus is one of the most important influences on print quality. After the effect of pressure on solids is understood, the study of uniform halftones will be undertaken, followed by the printing of combinations of halftones of different densities and of halftones with solids. In this manner conclusions reached in the simpler phases may be more easily modified as the complexity of the plate increases. Ultimately this work should be tied with numerical evaluation of halftone pictures.

Satisfactory completion of the work briefly outlines appears to be the only scientifically sound way of developing a true understanding of the behavior of inks in the most vital production step in the graphic arts industry.

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Lamination-Casting of Coatings for the Study of Printing Quality of Coated Papers

R. C. HYDELL

THE first machine-coated papers were utilized for letterpress printing. When substituted for uncoated M.F. and supercalendered papers in the magazine field, their use resulted in a marked printing improvement for both the printed solids and the halftones. Machine-coated sheets were surprisingly close, but not equal in letterpress printing quality, to a great number of the conversion-coated papers that were available in the early 1930's. The development of heat-set letterpress inks created a large market for machine-coated papers, and gave impetus to the development of new coating processes and the installation of considerable machine coating capacity.

After their success in letterpress printing it was only natural that machine-coated papers should be evaluated for other printing processes. The Mead Corp, because it is one of the leading suppliers of uncoated gravure printing paper, has repeatedly evaluated machine-coated paper for gravure printing in the laboratory, and in our customers' plants. It quickly became apparent that machine-coated papers, when printed by the rotogravure process on high-speed web-fed presses, did not produce the printing improvement that had resulted when these papers were introduced for letterpress printing. Definite improvement and satisfactory printing were obtained in the solids and heavy tones due to better ink coverage, and the snap and life or brilliance of the printed material were improved. However, from the halftone range down to the extremely light tones, a broken effect occurred that made the printed sheet unsatisfactory for many customers.

This problem was made the subject of a number of machine trials in which fiber furnish, coating formulation, coat-to-fiber weight ratio, and certain paper machine variables were investigated. After numerous trials had indicated that the deceptively easy problem of improving gravure high-light printing quality could not be solved by the usual methods, it was considered desirable to study the problem from the standpoint of determining individually those paper properties that are necessary for faithful tone reproduction by the gravure printing process.

We were fortunate in having available for this investigation a 7-in. web-fed gravure printing press capable of operating in a speed range of 300 to 500 f.p.m. When used as a control means for predicting the gravure printing qualities of certain uncoated grades of paper this press had established a good record for correlating with commercial printing. In addition to the gravure press, there was available a laboratory coater equipped with a machine coating process capable of operating at speeds up to 700 f.p.m. For this investigation, the laboratory coater was modified by the addition of an extra reel stand so that two webs could be simultaneously fed to the coating unit.

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THE TECHNIQUE OF LAMINATION-CASTING

As illustrated diagrammatically in Figs. 1 and 2, a procedure was developed several years ago whereby coated surfaces of controlled surface smoothness could be produced with a variety of coating formulations. Referring to Fig. 1, coating is applied to applicator roll A by a suitable arrangement of metering rolls. Cellulose acetate film of 0.003 in. thickness is supplied from reel D, to be coated at the nip formed by the coating applicator roll A and its mating roll B. Simultaneously, rawstock supplied by reel stand E is fed to the laminating-casting nip formed by the rolls B and C. This laminated sandwich may be seen in greater detail in Fig. 2, where layer no. 1 represents the cellulose acetate, no. 2 the coating film, and no. 3 the coating rawstock.

The two rolls B and C that form the laminating nip must travel at very nearly the same surface speed. On our coater, these rolls were driven by separate adjustable speed motors. For rapid speed control and adjustment, the ends of the two roll shafts were fitted with stroboscope disks on which the angular spacing of radial lines was so adjusted that when both rolls were traveling at the same surface speed, the lines appeared stationary when the disks were illuminated with the G.R. Strobotac. This permitted very close speed adjustment. Any appreciable speed differential at this point causes one sheet to slip with respect to the other, and in such a case the coatings may develop a very objectionable skip pattern, and, in extreme cases, wrinkling or buckling will occur. The tensions on the rawstock and acetate webs must be so adjusted that neither web flutters when moving into the laminating nip.

In this investigation it was found convenient to thread the coater by the use of an inching switch on the drive motors, first leading the acetate strip through both coater nips, and then threading the paper into the B-C nip. The coating was applied to applicator roll A after threading the machine, and during the time required to accelerate from threading speed to 700 f.p.m. The coater could be stopped in a few seconds by means of a mechanical hand brake after a relatively short period of 1 to 3 min. operating time. After several days' experience, operation of this unit became fairly efficient, and samples were produced at an average rate of one every 15 min. After strips had been prepared by this laminating-casting technique, they were allowed to thoroughly air dry for a period of 6 to 12 hr. after which the acetate was removed by peeling it from the coated sheet. For best peeling relatively slow air drying was found to be preferable to rapid oven drying. Color formulas with high starch or high carbonate contents peel readily from these acetate strips. Their opposites require a light waxing or wax polishing of the acetate in order to permit clean peeling. It is essential that the acetate peel cleanly and easily from the coated surface in order to avoid surface imperfections from coating pick-outs.

Some coating formulations will not "wet" the waxed acetate surface uniformly, and the lamination-castings will be imperfect in surface because of this phenomenon. A finger smear-out of the color on waxed acetate satisfactorily predicts the existence of a wetting problem inasmuch as poor wetting causes the smeared color film to draw into beads as it dries. The addition of a small quantity of a wetting agent to the coating color will avoid this problem. The application of the coating to the acetate film, with subsequent lamination to rawstock, is preferable to the alternate procedure of applying the wet coating film to the rawstock. The time interval between the coating application and the lamination was found to

have a pronounced effect on the results obtained when the coating was applied to the rawstock. Coating color penetration into the rawstock takes place very rapidly, and differences in surface perfection or in coverage can be noted when exposure times for penetration are varied by $^1/_{500}$ sec.

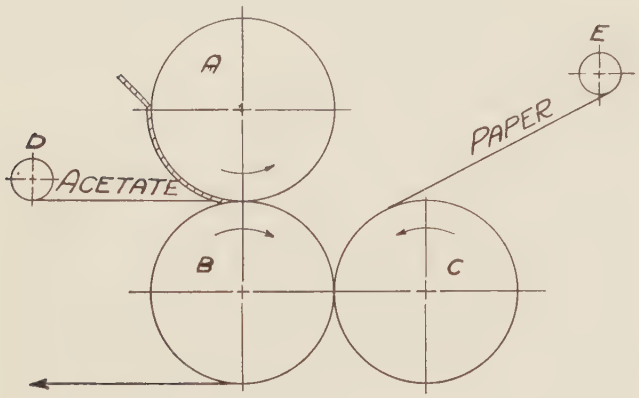

Fig. 1

With this technique it was determined that the minimum coat weight that will give complete coverage is very dependent on the surface of the rawstock and on the wet film thickness of the coating applied. Insufficient coat produces an imperfect coating and may be recognized by the presence of small semibare spots (air pockets) appearing between the acetate film and the rawstock prior to peeling of the acetate film. Incidentally, this appears to be a good means for determining the minimum coat weight necessary to cover any given rawstock.

After drying and peeling, the coated paper was cut into strips of 17 in. length for calendering, testing, and printing. These strips were spliced into a reel of suitable printing stock by means of Scotch tape, and were printed in continuous web form on the gravure printing press.

The procedure of coating onto a smooth, nonabsorbent acetate film, with subsequent lamination to a coating rawstock, made it possible to produce a great number and variety of laboratory coatings for which the important variable of coated paper surface was controlled at a high level of perfection. This technique for the lamination-casting of paper coatings to cellulose acetate film proved to be a very valuable research tool, but to appreciate its significance, it is first necessary to comment on certain problems that are faced by all those who are working in the field of machine-coated papers.

FACTORS AFFECTING TONE REPRODUCTION IN GRAVURE PRINTING

Coating color formulation variables may influence the final printing results obtained on machine-coated paper in several ways. The most important of these is the nature (magnitude or roughness) of the film split pattern in the coating remaining on the web. All machine coating processes applying the coat to the web by means of rolls traveling in the direction of the forward-moving web are subject to more or less of a pattern which results when the wet coating film is split (necked down) at the exit of the coat applying nip. Coating color solids, coating color viscosity, and other rheological properties play an important part in the magnitude and distribution of the pattern remaining on the coated web. Color formula manipulation can minimize or improve this pattern, but no means has yet been perfected for eliminating all patterning in commercial roll coating processes. This pattern has been shown to have a pronounced effect upon the gravure printing results obtained with laboratory and commercial printings.

A second important influence that coating formulation has on the final quality of the coated web manifests itself in the action of the supercalender in smoothing coated surface imperfections. When subjected to the high pressure of supercalendering, the rearrangement of pigment particles, as well as the polishing action obtained, will vary considerably with the selection of the mineral components of a coating formula, and with the plasticity of the suspending medium or adhesive binder.

A third method by which coating formulation variables affect printing results relates to the influence of these variables on the ink acceptance or surface ink wettability of the coated-calendered paper surface. While calendering materially improves surface smoothness, it simultaneously has a marked (and sometimes drastic) effect on ink acceptance. The initial ink absorbency and the web's ink affinity after supercalendering are a function of the particle size, shape, and particle arrangement existing in the coating film, and are influenced by the type, quantity, and distribution of the adhesive in the coating film. The degree of compacting of the pigment particles is another important variable.

Similarly, rawstock affects the final printing results because it also influences the lay of the coating (or the pattern) on the web by reason of its smoothness or roughness, and through its absorbing capacity. For machine coating, it is usually necessary to have a smooth-surfaced rawstock, and the method used to obtain this surface smoothness may have profound effects on the absorbency of the rawstock.

Rawstock also influences the final results by affecting the plasticity on supercalendering. The relative movement or rearrangement of coat in relation to fiber will be dictated in large measure by the mobility or resistance to flow encountered

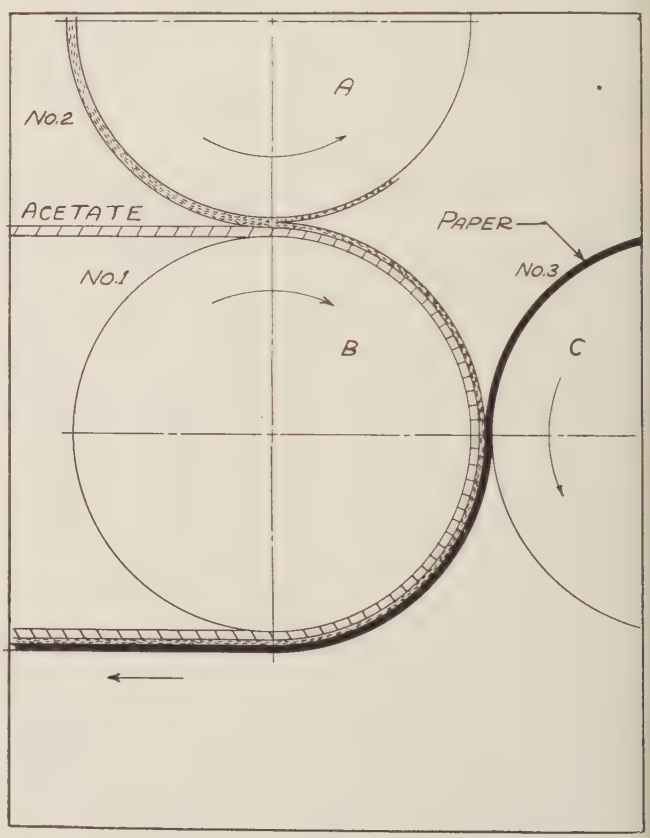

Fig. 2

in the supercalender nip, as influenced by each of these components. Hard, dense, compacted rawstocks interfere with coat pattern rearrangement, while soft, pliable, and flexible rawstocks allow the coating and rawstock to be blended together into a homogeneous mass.

Rawstock has an effect on the ink acceptance of coated paper. The level or rate of ink absorbency will be somewhat influenced by the rawstock. However, the most important effect is the uniformity of ink acceptance from one small area to the next.

The requirements in respect to the various coating color constituents and rawstocks are a function of the coating process and certain limitations are usually imposed on the choice of materials and coating color rheological properties by the particular coating process involved.

The technique of lamination-casting, which can be made to provide an essentially perfect coated surface without supercalendering, enables one to separate the printing characteristics of a coating color formula or a rawstock from its roll coating and calendering peculiarities. We believe that this is a great stride forward in enabling the papermakers to develop basic understanding of many coating problems.

As part of this study, certain variables of the gravure printing process were investigated to determine their influence on printing results with machine-coated papers. The press speed of the web within the speed range available had but a minor effect on halftone and high-light reproduction. Results from the ink formulation variables that were investigated led to the conclusion that the slowest evaporating solvents are desirable. Limited experience with depth of etch was not sufficient to be conclusive, and its effect on the faithfulness of high-light reproduction could not be demonstrated. Probably the most significant printing variable influencing high-light reproduction is the nip pressure applied to the back-up roll which maintains contact of the paper web with the etched cylinder. Higher nip pressure at this point greatly influences gravure printing, and consistently improves the fidelity of high-light reproduction. Similarly, a change in the hardness of this back-up roll produces an effect which is greater than can be produced by the normal quality differences existing among several grades of regular machine-coated paper; i.e., the harder the plasticity of the back-up roll, the cleaner and more accurate the high-light printing results.

RESULTS OBTAINED FROM LAMINATION-CASTING STUDIES

The high-light printing of all lamination-casting papers is outstandingly better than that of the usual machine-coated papers, as well as appreciably better than that of high-grade uncoated supercalendered paper and conversion-coated paper. Only on these sheets and on commercially available cast-coated papers is the dot pattern distinctly and clearly visible in the extreme high-light printing areas.

The influence of coat weight was investigated over a wide range. Comparable gravure printings were obtained for all those sheets in this series for which the coat weight was high enough to provide complete coverage of the rawstock. It was concluded that coat weight *per se* is relatively unimportant.

The effect of varying quantities (6 to 50%) of starch adhesive was studied in a simplified color formula in which the mineral components were clays. In this series, the light tone dots are all well reproduced. However, they lose slightly in definition at the higher starch concentrations. Contrary to expectations, 25 and 50% starch adhesive do not show creepiness in the solid black areas. A possible explanation may be that the increased resistance due to high starch concentration allowed some leveling of the ink to occur before ink drying was complete. Lower brightness at high starch concentration detracts from the printing results in that poorer visual contrast is obtained.

Calcium carbonate content of the coatings was varied from 0 to 100% of the mineral furnish. The high carbonate coating demonstrates a marked superiority over low carbonate sheets in contrast, brightness, and ink acceptance in the solids. The high-light reproduction was not improved with higher carbonate contents. However, the printing results are superior due to the absence of ink creepiness or worming in the heavier tones.

Domestic clay, in comparison with English clay, did not offer any basis for preference in printing characteristics, although the higher brightness of the English clay coated paper was noticeable in the printing contrast.

Further comparisons were made to determine the effect of the type of adhesive used. There is no basis for preferring casein over starch insofar as gravure printing tone quality is concerned. Similar results were obtained with other adhesives not generally used for machine coating.

A variety of rawstocks, including several supercalendered papers, were compared by this technique. No appreciable difference was indicated in the printing results, and the only advantage to be associated with smoother surfaced rawstock, even in the case of supercalendered rawstocks, is that it appreciably reduces the coat weight required for complete coverage.

The effect of various addition agents often used in machine coating color formulations was determined. In the additive range studied, soap, ink wetting agents, phosphate dispersers, sulphonated oil, and glycerine had but minor effect on printing results. Satin white, as a coating pigment, gave results similar to high calcium carbonate content.

Supercalendering of the laminated-casting sheets produces no appreciable change in their printing characteristics except in cases of extremely hard calendering where ink acceptance in the solid printed area is reduced, and a creepiness in the lay of ink is apparent.

SUMMARY

Gravure printing demands an extremely smooth printing surface in order to achieve fidelity of tone reproduction. Rawstock and coating formulation variables are important only insofar as they affect the surface smoothness of the finished coated paper. However, instantaneous ink wettability of the coated surface and a high level of ink absorbency are necessary for optimum printing in the heavy tones and solid printed areas. Surface smoothness requirements for gravure printing are more stringent than those normally demanded of no. 1 conversion coated papers which are printed by the letterpress process.

The relatively poor high-light printing quality of machine-coated papers has limited their use for gravure printing. The coating film split pattern, developed when the coating applying roll and paper web are separated, is a major cause of the surface defects in machine-coated paper that result in the failure of most of these papers to give satisfactory tone reproduction. It is believed that this film split pattern prevents the coated paper surface from contacting all of the ink cells of the gravure cylinder. A similar effect is sometimes observed in letterpress printing in the opposite end of the tone scale, namely, in the solid areas, when printings are made on machine-coated paper having an excessively patterned surface. The necessity for obtaining an optically flat surface would indicate that for machine coating we should have a smoother surfaced and more plastic rawstock, together with a low adhesive, highly plasticized coating color. However, this approach has been only partially successful in improving gravure printing results with machine coating. Coating process modifications to eliminate the coating film split pattern would, of course, provide a decided advantage.

At the present time, production of extremely smooth surfaces on machine-coated papers remains "The toughest job in the world." It is a real challenge to the papermaker, but the industry has successfully met similar challenges in the past. It may require years—possible 5 to 10 years—but eventually the papermaker will find a way to produce the ultimate in surface smoothness on machine-coated papers. When the goal is finally realized, both the gravure printer and the paper industry will have reason to feel that a new milestone in printing perfection has been attained.

A Rheological System for Analyzing the Flow Properties of Pseudoplastic and Thixotropic Pseudoplastic Materials

R. N. THOMPSON and G. D. HANSEN

THE need for a fundamental system of analyzing the flow properties of pseudoplastic and thixotropic pseudoplastic materials has been recognized for some time. The late Henry Green(*1*) laid a firm foundation for the study of materials which exhibited Newtonian plastic and thixotropic plastic flow. This paper presents an analogous system for the study of materials which exhibit pseudoplastic and thixotropic pseudoplastic flow. This system will apply only to these two types of flow below the dilatant level.

The basic assumption made in the development of this system is that rate of shear applied in rotational type viscometer must be varied exponentially to produce a unit change in the measured shearing force. The validity of this assumption will be demonstrated.

If a true pseudoplastic material is tested in a rotational type viscometer and the natural logarithm of the angular velocity, ω, is plotted versus the natural logarithm of the corresponding torque, T, a linear relationship will be found to exist above some value of ω where the velocity gradient, dv/dr, between the cup and bob becomes uniform (see Figs. 1 and 2). The dotted lines show the extrapolated values for T and ω assuming dv/dr, to be uniform from the origin. Calling the angular velocity above the point where dv/dr becomes uniform ω_a, the equation for the linear portion of the actual consistency curve will be

$$\ln \omega_a = a + b \ln T \qquad (1)$$

where a and b are constants. Equation (1) may be written

$$\omega_a = Ae^{b \ln T} \quad \text{(see note)} \qquad (2)$$

Equation (2) gives the general form of the consistency curve. Its form appears reasonable in view of the fact that the distribution of bond energy values follows the quantum mechanical probability function for an electron with respect to two nuclei, which is also exponential. In order to dissolve these bonds the work applied must follow a similar exponential function. Therefore in order to induce a unit change in the shearing force, the rate of shear must be increased exponentially.

Differentiating equation (1) gives

$$b = \frac{d(\ln \omega_a)}{d(\ln T)} = \frac{\dfrac{d\omega_a}{\omega_a}}{\dfrac{dT}{T}} \qquad (3)$$

and

$$\frac{dT}{d\omega_a} = \frac{T}{b\omega_a} \qquad (4)$$

where b = the slope of the exponential curve.

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Note: For ease in following the transformation from equation (1) to equation (2) the following explanation is given. By definition of natural logarithms the following equations have the same meaning:

$$e^{\chi} = n \qquad \ln n = \chi$$

Applying this basic concept to equation (1) this equation may be written

$$\omega_a = e^{(a + b \ln T)} \qquad (1a)$$

From the law of exponents which states that the product of two or more powers of the same base is equal to that base with an exponent equal to the sum of the exponents of the powers, equation (1a) may be written

$$\omega_a = e^a e^{b \ln T} \qquad (1b)$$

Since e^a is a constant it may be designated as the constant A and equation (1b) becomes

$$\omega_a = Ae^{(b \ln T)} \qquad (2)$$

Referring to Fig. 1 at any point P on the consistency curve, the tangent to the curve is given by the tangent of the angle TPT_0. Therefore

$$\tan \angle TPT_0 = \frac{dT}{d\omega_a} = \frac{T - T_0}{\omega_a} \qquad (5)$$

Equating equations (4) and (5) and solving for T_0 gives

$$T_0 = \frac{T(b - 1)}{b} \qquad (6)$$

Replotting the data for equation (1) and substituting $T - T_0$ for T also gives a linear plot. The equation for this line is

$$\ln \omega_a = d + f \ln (T - T_0) \qquad (7)$$

The equation for any point on this line is

$$\ln \omega_a = k + \ln (T - T_0) \qquad (8)$$

where ω_a is directly proportional to the rate of shear, dv/dr, and $T - T_0$ is directly proportional to the shearing force F, equivalent to the force component of the angle TPT_0 in Fig. 1, and k is a function of the slope and displacement of the curve.

Equation (8) may therefore be written

$$\ln \frac{dv}{dr} = k' + \ln F \qquad (9)$$

which becomes

$$\frac{dv}{dr} = \frac{1}{\phi} F \qquad (10)$$

where ϕ is the pseudoplastic viscosity in poises at any point, P, and the rate of shear, dv/dr, is expressed in reciprocal seconds and the shearing force F, is expressed in dynes per square centimeter. Equation (10) gives an expression of the shearing force in terms of the rate of shear and is of a form which may be integrated for use with the results obtained in a rotational type viscometer.

Since the shearing force F, is equal to the torque divided by the radius and area of any hypothetical cylinder of material between the cup and bob, then from equation (6)

$$F = \frac{T - T_0}{2\pi r^2 h} = \frac{T}{2\pi r^2 hb} \qquad (11)$$

Referring to equation (10) Green has shown that

$$\frac{dv}{dr} = \omega + r \frac{d\omega}{dr} \qquad (12)$$

and that since ω is the angular velocity all the cylinders of test material between the cup and the bob would have if no internal shearing took place, the internal stresses are derived from the last term only of equation (12).

Substituting equation (11) and the last term of equation (12) in equation (10) gives

$$r \frac{d\omega}{dr} \phi = \frac{T}{2\pi r^2 hb} \qquad (13)$$

Integrating equation (13) gives

$$\omega\phi = -\frac{T}{4\pi r^2 hb} + c \qquad (14)$$

When $r = R_b, \omega = 0$, then

$$c = \frac{T}{4\pi R_b^2 hb} \qquad (15)$$

Substituting equation (15) in equation (14) gives

$$\omega\phi = \frac{T}{4\pi hb} \left(\frac{1}{R_b^2} - \frac{1}{r^2} \right) \qquad (16)$$

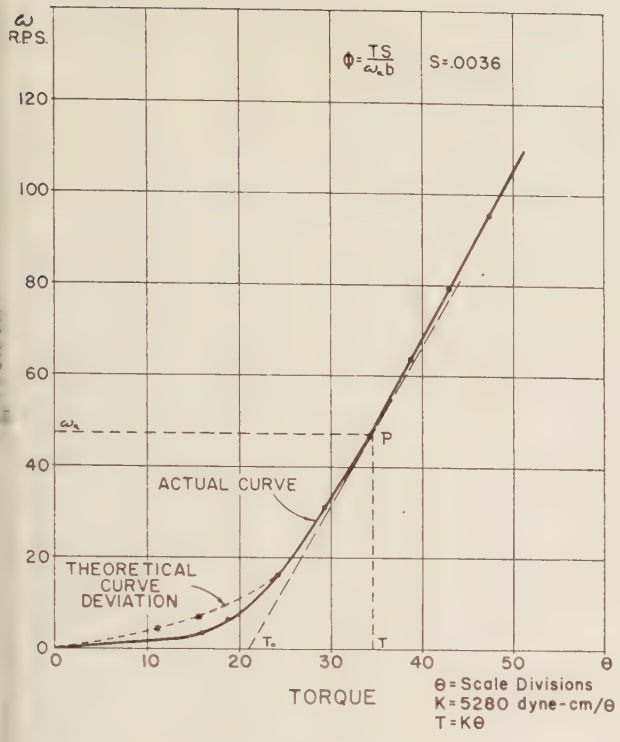

Fig. 1

Then dv/dr becomes uniform, then let $\omega_a = \omega_a$ and equation comes

$$\omega_a \Phi = \frac{T}{4\pi h b}\left(\frac{1}{R_b^2} - \frac{1}{R_c^2}\right) \tag{17}$$

et

$$\frac{\left(\frac{1}{R_b^2} - \frac{1}{R_c^2}\right)}{4\pi h} = S \tag{18}$$

hich is the same instrumental constant as Reiner's and all mensions are expressed in centimeters. The slope b, of e exponential curve may be found from

$$b = \frac{\ln \omega_a 2 - \ln \omega_a 1}{\ln T_2 - \ln T_1} = \frac{\ln \frac{\omega_a 2}{\omega_a 1}}{\ln \frac{T_2}{T_1}} \tag{19}$$

quation (17) may be written

$$\phi = \frac{TS}{\omega_a b} \tag{20}$$

here ϕ is expressed in poises, T in dyne-centimeters, ω_a radians per second, and b is dimensionless. Equation 0) is the basic equation for determining the pseudoplastic scosity. Since ϕ is a function of the rate of shear, it will necessary to specify the rate of shear for a corresponding lue of ϕ. Green has shown that the rate of shear may be sely approximated when $(R_c - R_b)$ is small by

$$\frac{dv}{dr} = \omega k \tag{21}$$

here $k = \dfrac{1}{2\pi\left(\dfrac{R_c + R_b}{2}\right)^2 hS}$ and S is Reiner's instrumental stant for plastic flow.

Referring to Fig. 1 it can be seen that the total loss in torque going to point P is T_0 for the effective torque at point P is $- T_0$ as was shown by equation (5). Assuming the loss in torque due to pseudoplastic breakdown to be proportional to the rate of shear and using equation (21) gives

$$T_0 = \frac{Z}{2\pi r^2 hS} \tag{22}$$

where Z is the proportionality factor. Z then becomes the loss in torque per unit increase in rate of shear. As Green has pointed out, the ratio Z/r is constant between R_b and R_c.

Differentiating equation (22) and letting the constant $\dfrac{Z}{2\pi r^2 h} = \dfrac{1}{m'}$ gives

$$dT_0 = \frac{d\omega}{m'S} \tag{23}$$

Differentiating equation (6) and substituting in equation (23) gives

$$\frac{d\omega}{m'S} = \frac{dT(b-1)}{b} \tag{24}$$

Differentiating equation (20) gives

$$dT = \frac{b}{S}\, d(\omega\phi) \tag{25}$$

Substituting equation (25) in equation (24) and integrating gives

$$\frac{\omega}{b-1} = m'\omega\phi + c \tag{26}$$

If $\omega/(b-1)$ is plotted versus $\omega\phi$ a linear relationship is found The slope of the line is m' (see Fig. 3).

Let $1/m' = H$. Then

$$Z = H2\pi r^2 h \tag{27}$$

Since Z is the loss in torque per unit increase in rate of shear, H is the loss in shearing force per unit area per unit increase in rate of shear. H is then the coefficient of pseudoplastic breakdown. Using equation (26) and two points $(\omega_1\ \phi_1)$ and $(\omega_2\ \phi_2)$ gives

$$H = \frac{(b-1)(\omega_{a2}\phi_2 - \omega_{a1}\phi_1)}{(\omega_{a2} - \omega_{a1})} \tag{28}$$

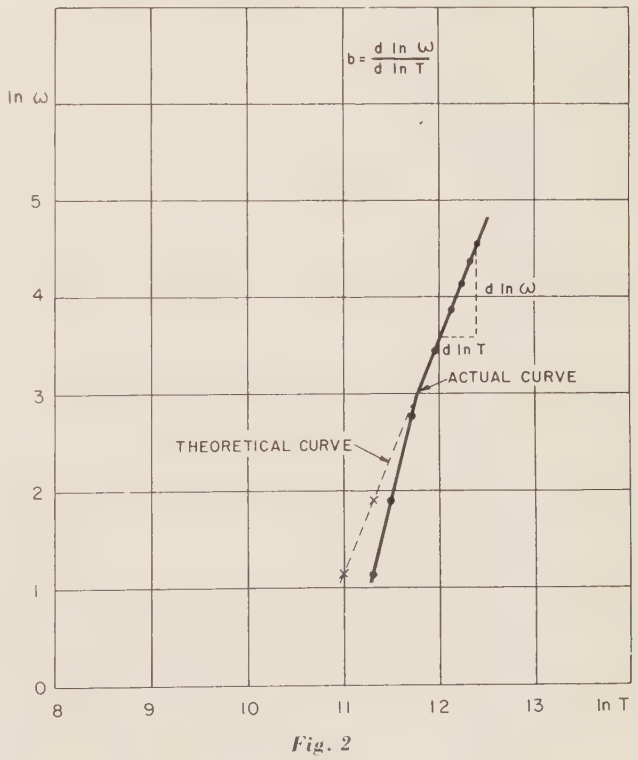

Fig. 2

where ϕ is expressed in poises and ω is expressed in radians per second. H contains no time element since the change in pseudoplastic breakdown with change in the rate of shear appears to take place instantly. The truth of this becomes apparent upon studying pseudoplastic rheograms where the time involved in making the rheogram is varied. As the rate of shear in a rotational viscometer is varied the corresponding equilibrium torque is instantly established. No matter how long a pseudoplastic is subjected to a given rate of shear, there will be no decrease in the corresponding torque from its initial value at that rate of shear. This situation of course does not hold for a material which exhibits thixotropy.

If a pseudoplastic material is also thixotropic, it now becomes possible to determine its coefficient of thixotropic breakdown. If a hysteresis loop is obtained for a thixotropic pseudoplastic by the Green method, the down curve may be considered as an exponential curve passing through the points $\omega = 0$ $T = 0$ $\omega = \omega_{a1}$, $T = T_1'$ and $\omega = \omega_{a2}$, $T = T_2$ (see Fig. 4). From equation (19)

$$b' = \frac{\ln \frac{\omega_{a2}}{\omega_{a1}}}{\ln \frac{T_2}{T_1'}} \qquad (29)$$

for the down curve. From equation (20)

$$\phi_1' = \frac{T_1' S}{b' \omega_{a1}} \qquad \phi_2' = \frac{T_2 S}{b' \omega_{a2}} \qquad (30)$$

Using equations (28), (29) and (30) gives for the down curve

$$H' = \frac{(b' - 1)(\omega_{a2}\phi_2' - \omega_{a1}\phi_1')}{(\omega_{a2} - \omega_{a1})} \qquad (31)$$

H' represents the loss in shearing force per unit area per unit increase in the rate of shear due to the pseudoplasticity of the system after it has undergone thixotropic breakdown. Therefore H for the up curve minus H' for the down curve will be equal to the loss in shearing force per unit area per unit increase in the rate of shear due to thixotropic breakdown and hence $H - H'$ will be proportional to the loop area.

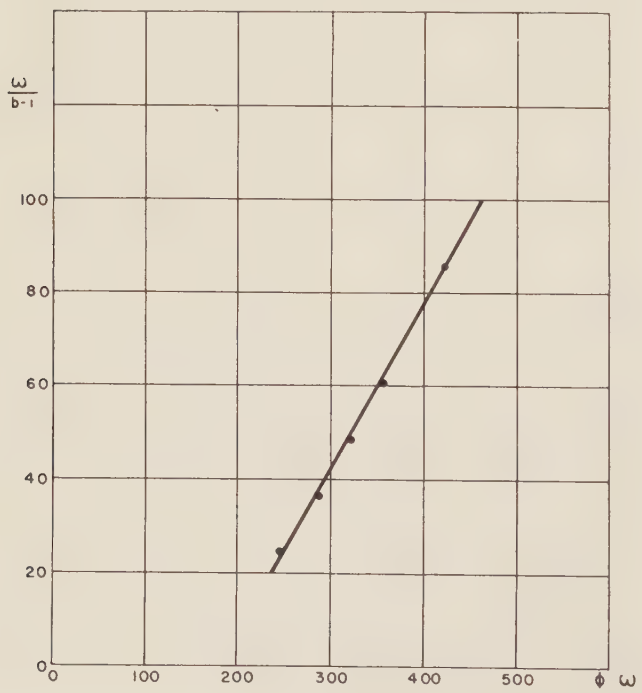

Fig. 3

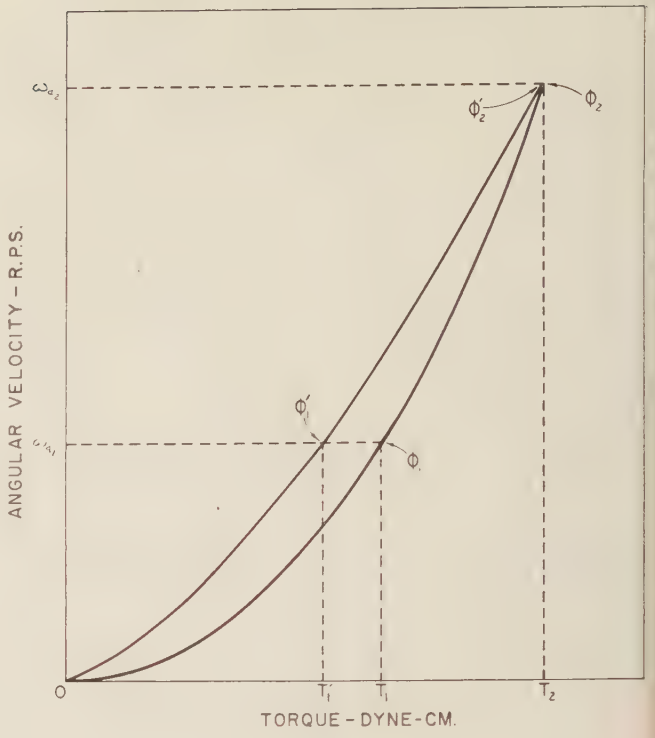

Fig. 4

Let M' be the coefficient of thixotropic breakdown in a thixotropic pseudoplastic. Then

$$M' = H - H' \qquad (32)$$

It is obvious from the foregoing that the coefficient of thixotropic breakdown, M' for a thixotropic pseudoplastic must be calculated indirectly and is not subject to direct calculation as in the case of a thixotropic plastic. This indirect approach is somewhat more tedious than the method used for plastics, but is the only way the authors have been able to devise for calculating the thixotropic breakdown for pseudoplastics.

The work of Trelfa *et al.* (*2*) has shown the development of a leveling index for thixotropic plastic coating colors used in the machine coating of paper. It was defined as M for a thixotropic plastic divided by the plastic viscosity determined at the top angular velocity of the consistency curve. For thixotropic pseudoplastics, the leveling index will be

$$I = \frac{M'}{\phi_2} \qquad (33)$$

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1. Green, H., "Industrial Rheology and Rheological Structures," New York, John Wiley & Sons, 1949.
2. Smith, J. W., Trelfa, R. T., and Ware, H. O., *Tappi* 33, No. 5: 212–218 (May, 1950)

Hot Resin-Coated Papers as Barrier Materials

L. M. BURGESS and L. F. SWEC

COATING with paraffin is quite old in the converting industry. The early attempts that were made to harden paraffin led into the compounding of "hot melts." These hot melts were composed of resins such as ester gum, plasticizer, wax, and a high polymer material such as ethyl cellulose. The compounds were formulated for the then existing coating

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quipment. Because this equipment was suitable only for the coating of low viscosity materials, the film former was, by necessity, present in small amounts and the plasticizer was present in rather large amounts and served the dual function of dissolving the film former and keeping the viscosity of the melt low. Resins such as ester gum added hardness and mixtures of wax were used in small amounts to prevent blocking and add water vapor resistance to these melts. The upper limit in viscosity at the coating temperature (approximately 300°F.) was about 100 poises.

The weaknesses in this type of melt were many. To begin with, the high percentage of polymer diluent necessary to maintain low coating viscosities resulted in films that were low in strength. This low film strength precluded the use of long-fibered base stocks because of the susceptibility of the film to fiber rupture. In fact, most "melts" were coated onto glassine, well-hydrated tissues, and lacquering papers. The high plasticizer content of the "melts" made the coated paper very susceptible to blocking.

These melts do, however, have some advantages. They are excellent heat sealing materials and are still used for this purpose. They also have good water vapor resistance and when properly compounded, good grease resistance. These coatings, furthermore, can be compounded for high gloss and scuff resistance, a use that still exists.

To the early workers in the field, it was apparent that the lack of film strength was the great weakness of these materials. Therefore, considerable effort and time were devoted to try and increase the amount of high polymer in the melt. Most investigators felt that mixtures of high polymer resin and plasticizer only would be the ideal coating material. The limiting factor on the percentage of high polymer was always the inability of the equipment to handle a highly viscous melt.

COATING METHODS

The advent of polyethylene quickly changed the picture. Its properties seemed almost ideal as far as a finished coating was concerned. The greatest stimulus, however, was its high film strength, its relatively low viscosity, and the fact that no compounding was necessary for flexibility. The lower molecular weight could be coated on normal waxing equipment. In 1945, Imperial Chemical Industries developed a hot knife coater on which they were able to produce satisfactory coatings on paper. On this equipment they coated polyethylene resins ranging from those low in molecular weight and melt viscosity to ones as high as 20,000 molecular weight with a melt viscosity of at least 10,000 poises.

One problem that existed was melting the resin. All investigators finally agreed that the best method was to use an extruder.

The extruder used for melting a high polymer material such as polyethylene is merely a long cylindrical barrel in which a screw revolves. A hopper is provided for charging in the resin, and a die head is attached at the opposite or delivery end. There are provisions made for heating and cooling. It functions as a melter in this manner. The screw takes the resin fed to it and by mechanically working the resin along the length of the heated barrel it raises its temperature to a point where viscous flow occurs and forces the molten mass through the die head which shapes or forms the material into sheets or rods. Usually the hopper zone is kept cool and the temperature gradually increased along the barrel to a maximum at the die head. The screw is hollow to permit water cooling during operation if necessary. A screen is provided at the end of the barrel to hold back foreign particles in the melted resin. The extruder must be periodically cleaned to remove foreign particles and decomposed or oxidized resin. It is important to chill the extruder rapidly after stopping to prevent decomposition of the resin remaining in the barrel and die head.

Figure 1 is a schematic diagram of a polyethylene extruder. The molten resin being delivered from the extruder die head

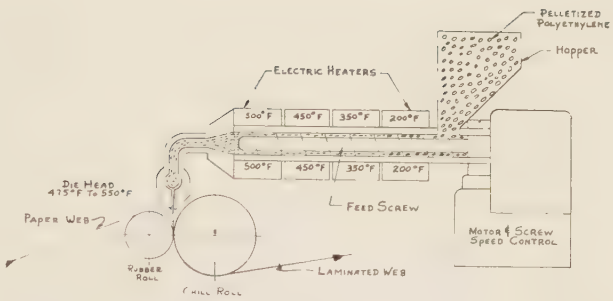

Fig. 1

may be anywhere in the temperature range of 300 to 600°F. This temperature depends on the viscosity and stability of the resin being extruded. For maximum extruder production usually the stability becomes the limiting factor determining temperature. For example, polyethylene and S-Polymer can be delivered at the upper end of the above range without serious decomposition whereas saran and vinyl copolymers must be extruded at the lower end of the above range.

The molten plastic is then coated on a traveling web such as paper by one of two methods. The hot resin coating method consists of metering the desired thickness of plastic (in the range of 1 to 10 mils of coating) on the paper by the use of a series of rolls. Viscosities of the molten resin up to 15,000 poises have been successfully run by this method. The shape of the extruder die head used for resin delivery is relatively unimportant compared with the second method known as extrusion lamination. In this operation a carefully metered film is extruded from an accurately controlled sheet die head. The hot film is stretched in the molten form from its original thickness (that of the die head) to $^1/_2$–$^1/_{20}$ its original thickness within a very short distance from the die head. The hot film is applied to the paper between a rubber and metal roll. The pressure between these rolls gives the adhesion of the hot film to the paper.

The primary advantage of the hot resin coating method is the good adhesion of coating to backing that can be obtained with any given combination of raw materials. This is important in applications involving heat sealing and as a release sheet from tacky materials. Although all the plastics discussed below have not been coated by the extrusion lamination method, it is believed that the hot resin method will be applicable to a wider variety of plastics and formulations than the extrusion lamination method. This is based on the fact that forming perfect films from an extruder die head, which must also be susceptible to hot stretching is not easily done with some resins. The advantage of the extrusion lamination method is that thinner continuous films (down to $^1/_2$ mil) can be applied. Also lighter weight papers with lower strength can be used because the tension on the traveling web is not as great. These factors are very important for economy, of course. The problem of maintaining coating uniformity across the web is a serious one in both operations, although wider machines have been successfully built for extrusion lamination.

These two types of coated papers must compete with older, existing methods of applying plastics to paper. These include solvent-coated papers and film lamination to paper with adhesives. Solvent coating is a more expensive operation because of the solvent used and the drying required. It is difficult to get heavy coatings but has the advantage of being able to apply the lightest possible coatings on smooth surfaces with very good adhesion. Film laminations with adhesives are inherently more expensive also because the cost of film manufacture from the base resin and the adhesive cost are additional to the basic costs of the paper and resin plus the combining operation. In addition, it is difficult to find adhesives for many film laminations which give a good permanent bond. Coated papers must also compete with unsup-

ported films in some cases. For the same thickness of resin the barrier properties are usually very similar. Unsupported films have the additional properties of clarity and lightweight whereas coated papers have greater strength, rigidity, and can be printed and heat sealed more readily. There are obviously large separate fields for both unsupported films and coated papers.

SPECIFICATION AND CONTROLS

The raw stock used for coating must have rigid specifications in certain respects. Usually a minimum MD tensile strength is required depending on the severity of the operation. Caliper variation, particularly from one edge of the web to the other, must be avoided as much as possible. The adhesion of the coating depends to a great extent on the nature of the surface of the stock. No satisfactory measurement of this surface which can be related to the adhesion of the coating has been found. However, it is known that a rough, hairy surface gives the best adhesion and also requires more coating to get a continuous film. Usually the surface definition is related to such factors as density, porosity, sizing, and type of machine finish. A high moisture content in the stock at the point of coating is undesirable and usually preheating the stock just prior to coating is beneficial. Mill splices must also be carefully made so they are capable of going through the coating operation.

Specifications on the raw polymers used for coating consist of uniform viscosity, cleanliness, stability for extrusion, and small pellets for maximum extrusion rates.

During the coating operation it is very important to have reliable controls which quickly indicate excessive variations as well as the production of an unsatisfactory product. Coating uniformity within an established range is the first item to consider. Usually coating weights of individual samples are checked as often as possible by extraction of the coating with a suitable solvent. Recently it has become possible to install beta ray gages before and after coating which automatically record the weights on a chart and which can also be moved to scan the web to give the coating weight profile across the web. Although this equipment is quite expensive it has the obvious advantage of giving a continuous record of a large area of the product. Another instrument that can be incorporated into the coating operation is one which continually measures and records caliper before and after coating.

Another property that must be frequently measured during the operation is freedom from pinholes in the coating. This is usually done by flooding individual samples with a colored liquid that wets the plastic surface such as turpentine or water containing a wetting agent. It is frequently necessary to set a low maximum on the number of pinholes per unit area and test as many samples as possible during the operation. Studies are now in progress on an automatic refinement of this test using two electrodes, one on each side of the web, with a fixed voltage somewhere between the voltage breakdown of the uncoated stock and that of the coated stock. A counter then records the number of pinholes which permit the current to arc between the electrodes during the operation.

The bond of the coating to the backing must be frequently checked on samples taken during the operation. This is usually done qualitatively with pressure-sensitive tape or in some cases may be done quantitatively on a tensile tester.

BARRIER PROPERTIES OF HOT RESIN-COATED PAPERS

A number of polymers have been tried as paper coatings by the hot resin or extrusion lamination technique. At the present time only polyethylene and saran-coated paper made in this manner are being sold commercially. In the following discussion a group of well-known polymer types are compared for their properties on paper. All the samples were made by the hot resin coating technique except the FM6503 nylon which was coated by extrusion lamination in the E. I. du Pont de Nemours & Co. laboratory in Arlington, N. J. Approximately 2 mils of coating was applied to 45 or 60-lb. natural kraft in the case of all the hot resin-coated papers and a 1-mil coating of nylon on 45-lb. natural kraft was used for the results on this polymer. In Table I the six polymers investigated are compared for their yield in a 1-mil average thickness. The yield is inversely proportional to the specific gravity of the polymer. Polyethylene was the lightest and saran the heaviest of those studied.

Table I. Resin Coverage for Coated Papers

Resin	*Specific gravity*	*Lb./mil/3000 sq. ft. ream*	*Sq. ft./ lb./mil*
19,000 mol. wt. polyethylene	0.92	14.4	209
S-50 Polymer	0.97	15.1	198
FM6503 nylon	1.13	17.6	170
Vinyl chloride-acetate copolymer (VGGA-59139)	1.30	20.3	148
Cellulose acetate (Tenite I-S Flow)	1.30	20.3	148
Saran	1.68	26.2	115

Probably the most important property of plastic-coated papers in the packaging field is their water and water vapor resistance. Water vapor transmission rates measured in a General Foods cabinet at 100°F. and 90% relative humidity are usually directly proportional to coating weight for lightweight continuous film coatings. Table II lists the WVTR's and the exact coating weights tested for each polymer in the order of the best to the worst water vapor barrier. Since the coating thicknesses are not identical in all cases (particularly the 1-mil thickness of nylon), these results should be compared with the coating thickness differences in mind. Even with these adjustments, however, the order would remain the same. Saran is considered the best water and water vapor barrier of the polymers studied and cellulose acetate the worst. Saran, polyethylene, and S-Polymer are all considered very good water and water vapor barriers. Vinyl copolymers, nylon, and cellulose acetate are considered poor water vapor barriers, although they are all good liquid water barriers in the sense of being water insoluble. The water resistance test reported in Table II consists of applying a head of colored water on the coated surface and observing visible transfer through the coated sheet to a white backing sheet underneath. Since all the coated sheets studied had a continuous, pinhole-free plastic coating, none would permit the transmission of the liquid, colored water within 48 hr. However, those with a very high WVTR, such as nylon and cellulose acetate, trans-

Table II. Water and Water Vapor Resistance of Hot Resin-Coated Papers

Resin coating on 45–60-lb. nat. kraft	*WVTR flat and creased at 100°F.—90% R.H. (coated side exposed), g./100 sq. in./24 hr.*	*Water resistance (MIL-B-117A method)*
46 Lb./ream white pigmented saran X773.1 ($1^3/_4$-mil coating)	0.10	Very good, 48+ hr.
29 Lb./ream 19,000 mol. wt. polyethylene (2-mil coating)	0.59	Very good, 48+ hr.
31 Lb./ream S-50 Polymer (2-mil coating)	0.69	Very good, 48+ hr.
39 Lb./ream vinyl chloride-acetate copolymer (VGGA-59139) (2-mil coating)	11.2	Good, 48+ hr.
16 Lb./ream FM6503 nylon (1-mil coating)	24	Poor, approx. 1 hr.
35 Lb./ream cellulose acetate (Tenite I-S Flow) ($1^3/_4$-mil coating)	47	Poor, approx. 1 hr.

mitted water vapor at a fast enough rate to result in observable dampness of the white backing sheet in about one hour.

Since many present-day packaging problems involve handling at low temperatures, the various plastic coatings were compared for low-temperature flexibility. The results reported in Table III were obtained by forming a loop (coated side out) with a 3 by 11-in. sample and clipping the two 3-in. ends together. These clipped ends were attached to a horizontal rod extending into the cold chamber. After conditioning at the test temperature, the looped sample was rapidly pulled through a $^1/_8$-in. opening between two smooth, fixed, horizontal metal rods. The crease formed by the looped end of the sample passing through the narrow opening was examined carefully for any evidence of cracking. These creases were also checked on the coated side with colored water containing a wetting agent to determine whether the film had been ruptured. Polyethylene had the best low-temperature flexibility of the polymers tested. It must be remembered that the results obtained with the compounded polymers such as saran, vinyl copolymer, and cellulose acetate can be materially affected by the compounding ingredients used. The quantity and type of plasticizer especially affect this property. The two types of saran reported illustrate this effect in that the T715 formulation had a higher content of a different plasticizer than the X773.1 formulation. Usually compounding to give a better low-temperature flexibility results in a sacrifice of barrier properties such as WVTR.

Table III. Low-Temperature Flexibility of Hot Resin-Coated Papers

Resin coating on 45-60-lb. nat. kraft	*Brittle point of folded sheet through $^1/_8$-in. opening (coating out), °F.*
2 mils 19,000 mol. wt. polyethylene	below −65
1 mil FM6503 nylon	−50
2 mils cellulose acetate (Tenite I-S Flow)	−45
2 mils vinyl chloride-acetate copolymer (VGGA-59139)	−40
2 mils black pigmented saran T715	−30
2 mils S-50 Polymer	−20
2 mils white pigmented saran X773.1	−10

Another important property of a plastic-coated paper is the ability of the coated surface to heat seal to itself and the strength of the seam obtained. This permits the manufacture of flat pouches or bags on high production heat sealing machines from roll stock, which gives a tight package that cannot be obtained with conventional glued bags. In Table IV the coated papers studied are listed in the order of decreasing heat seal seam strength with S-Polymer giving the best result. The figure reported for nylon may not be comparable because of the lower coating thickness, although this property is not directly proportional to coating thickness. The heat sealing temperatures given are for comparative purposes only since they apply only to one set of conditions on a laboratory bar heat sealer. The variation of pressure and dwell time would give a different set of optimum conditions.

The mineral oil resistance of these coated papers is important in the packaging of metal parts which have a coating of preservative or lubrication oil. Small trays containing SAE 30 motor oil were made of the various plastic-coated papers and placed in an oven at 160°F. to accelerate the action of the oil on the coating. In Table V it can be seen that all the coatings except polyethylene and S-Polymer gave excellent resistance to the oil. The oil dissolved the S-Polymer under these conditions. Although the polyethylene was not dissolved, there was slow diffusion of the oil through the polyethylene which visibly stained the kraft paper in about 12 hr. Even after the paper is stained, however, the polyethylene is capable of holding the oil for a long period of time under these conditions.

Table IV. Heat Sealing Properties of Hot Resin-Coated Papers

Resin coating on 45-60-lb. nat. kraft	*Ideal heat sealing temp. at approx. 30 p.s.i. for 1 sec., °F.*	*Heat seal seam strength, lb./in.*
2 mils S-50 Polymer	375	6.7
2 mils white pigmented saran X773.1	325	4.7
2 mils cellulose acetate (Tenite I-S Flow)	400	4.5
2 mils 19,000 mol. wt. polyethylene	300	3.5
2 mils vinyl chloride-acetate copolymer (VGGA-59139)	400	3.4
1 mil FM6503 nylon	300	3.0

In the packaging of some organic materials, the permeability of plastic-coated paper to gases such as oxygen and carbon dioxide is significant. Of the polymers studied, saran is the best barrier for these gases, giving permeabilities in the range of 0.1 to 0.5 c.c. per 100 sq. in. per 24 hr. at room temperature and low relative humidity for a 2-mil coating. Nylon gives permeabilities 3 to 5 times as great and S-Polymer 50 to 100 times as great. Polyethylene and vinyl copolymers are considered quite poor barriers to oxygen and carbon dioxide.

Table V. Mineral Oil Resistance of Hot Resin-Coated Papers

Resin coating on 45-60-lb. nat. kraft	*Resistance to SAE 30 motor oil at 160°F., hr.*
1 mil FM6503 nylon	Excellent—168+
2 mils white pigmented saran X773.1	Excellent—168+
2 mils cellulose acetate (Tenite I-S Flow)	Excellent—168+
2 mils vinyl chloride-acetate copolymer (VGGA-59139)	Excellent—168+
2 mils 19,000 mol. wt. polyethylene	Fair—approx. 12
2 mils S-50 Polymer	Poor—approx. 3

With regard to general chemical resistance, saran and polyethylene have the greatest solvent resistance. They are not soluble in any solvents at room temperature although saran is attacked by a few special solvents at high temperatures and polyethylene is dissolved by hydrocarbons and chlorinated hydrocarbons at high temperatures. S-Polymer is soluble in hydrocarbons at room temperature. Nylon is quite alcohol soluble while vinyl copolymers and cellulose acetate are soluble in common ketones and esters Polyethylene has the best over-all acid and alkali resistance although S-Polymer and saran are quite good in this respect also.

OTHER HOT RESIN AND EXTRUSION LAMINATED PRODUCTS

In addition to paper, other backing materials such as aluminum foil and cotton or glass fabrics have been used, both in the hot resin coating process and the hot extrusion lamination process. The latter process has been successful in applying a polyethylene coating to aluminum foil, for example. Although the polyethylene can be separated from the foil, good bond strengths in excess of 1 lb. per in. width have been obtained. This product combines the outstanding barrier properties of aluminum foil and polyethylene. The inert polyethylene coating gives good resistance to acidic and alkaline materials as well as moisture which tend to attack and corrode aluminum. In rough handling the development of pinholes in the foil is compensated by the presence of the flexible waterproof film coating. The coating is heat sealable and heat-sealed bags made from this combination have many desirable properties.

Cotton fabrics with a wide range of thread counts and weights per yard have been coated with polyethylene and a few with saran by the hot resin coating technique. Part of the resin is driven into the interstices between the fibers to

give excellent adhesion. In the case of polyethylene adhesions of such magnitude have been obtained that make it impossible to separate the coating from the fabric without destroying the coating. These adhesions are known to be as high as 5 lb. per in. width. To obtain a continuous, pinhole-free coating with such adhesion usually requires 5 mils of coating or more. Experimental runs with glass fabrics have given essentially the same results as above. Considerable polyethylene-coated cotton fabric has been used in the manufacture of high quality pressure-sensitive adhesive tape.

Cotton fabrics have also been coated by extrusion lamination with polyethylene. In this case thin films as low as one mil, free of pinholes, can be applied to the cloth as to paper. Although the adhesion is satisfactory for many applications, in order to maintain film continuity the coating must remain on the surface of the cloth and can be removed more easily than the coatings discussed above.

MAJOR END USES

The properties of hot resin-coated papers discussed above indicate the important end uses. Polyethylene-coated paper is used as a waterproof and greaseproof packaging material for metal parts, both as a wrapper and as heat-sealed pouches. These sheets are usually made to meet the requirements of JAN-B-121 and JAN-P-117. Polyethylene-coated papers are also used extensively as locker papers or freezer wraps, as inner liners in mutiwall bags and fiberboard drums and as release sheets in contact with tacky surfaces. There are a variety of food and tobacco packaging end uses for polyethylene-coated paper also.

Saran-coated paper is finding important use where its outstanding water vapor and chemical resistance are needed, such as in packaging photographic film and as a cap liner. It is also being used as a greaseproof and water vaporproof packaging material for precision metal parts. Several food packaging end uses are also expected to be prominent in the future use of this product.

It is expected that S-Polymer coatings may find use in heat-sealed packages for food products where water and water vapor resistance are required. Cellulose acetate, vinyl copolymers, and nylon are all excellent grease barriers and should find uses as paper coatings in fields where special greaseproofness problems are encountered.

RECENT BOOKS

Conductimetric Analysis at Radio Frequency. By G. G. Blake. Chemical Publishing Co., New York, 1952. Cloth, $5^1/_2 \times 8^1/_2$, 132 pages. $2.75.

This book is an American edition of an Australian publication. It describes the author's new technique and methods of conductimetric analysis. This type of analysis (current/volume of reagent) is sometimes termed amperometric titration. He also supplies the information necessary to enable the reader to set up for himself reliable apparatus with which to carry out analyses and titrations. Radio-frequency technique is rapid and accurate. In addition to its use for common solutions, it is suitable also for the titration of colloid solutions, when precipitates are present, and for microtitration. Among the applications discussed are: alcohols, biology, papermaking, chemical purity, water, and control of chemical processes.

Modern Paper-Making. 3rd Ed. By R. H. Clapperton, Greenfield Paper Mill, Greenfield, Yorks, England. Basil Blackwell, Oxford, England, 1952. Cloth, $7 \times 9^1/_2$, 526 pages. $6.75.

Many papermakers in the United States and Canada have purchased the earlier editions of Clapperton's "Modern Paper-Making" and are familiar with its excellent contents.

The third edition has been made necessary by the tremendous advances which have been made in the past twelve years in stock preparation, paper-machine design, especially in regard to suction rolls, suction-transfer at high speeds, great developments in the manufacture of various qualities of pulps from a variety of woods, and also in the development which has taken place with precision machinery for the calendering, slitting, winding, and cutting of paper.

The new volume gives particular attention to the new pulps with their multistage bleaching processes, stock preparation, with the corresponding development of refiners and pulp slushing equipment. The subject of cleaning paper stock by a great variety of centrifuges is featured.

Much space is devoted to the wet-end development of paper machines, and in particular to the press part, with stacked presses, dual presses, suction transfer, etc.

The latest types of slitters and cutting machines are described and illustrated. There is an up-to-date chapter on dyeing of paper stock, on the treatment of water, and an effluent. Consideration is given to paper testing.

It should be kept in mind that the book has been written with a background of British practice. Considerable attention is therefore given to the manufacture of paper from rags, esparta, and straw. Some of the terms used may not be familiar to American papermakers but this does not detract in any way from the value of the book. In fact, its treatment of the subject of fine papermaking is a distinct contribution to the literature since no other major text on papermaking covers this field so thoroughly.

The large type used makes the book very readable. Excellent illustrations, 246 in number, add much to the interest. Much of the equipment illustrated is American made or made by affiliates of American companies. It is a book that should be in every paper mill library and in the libraries of papermakers and technical men. R. G. M.

The Newsprint Situation in the Western Region of North America. A Report by the Stanford Research Institute, Stanford, Calif. Paper, spiral wound binding, $8^1/_2 \times 11$, 115 pages. $10.

A report prepared for the California Newspaper Publishers Association by the Stanford Research Institute. The study was sponsored by 141 newspapers on the West Coast in collaboration with Powell River Co. Ltd., Crown Zellerbach Corp., Publishers Paper Co., and the Inland Empire Paper Co.

The report is unique in the history of the pulp and paper industry. It is the first time that a study of this nature has been jointly sponsored by publishers and manufacturers in an attempt to solve their mutual problem. It is undoubtedly the most objective and comprehensive report yet published.

Included in its contents are such items as: Demand and Supply, 1952–61; Purchases of Newsprint, 1929–51; Production and Supply of Newsprint, 1929–51; Demand-Price Consideration; Demand Estimating Techniques; Probable Newsprint Supply to the Western Region from Regional Producers; Estimated Rates of Return on Investment from 500-Ton, 2-Machine Newsprint Mill. The tables shown in the appendix are of great value.

Note: The books reviewed in this section may be obtained through the Recent Books Department of the Pulp and Paper Industry, 122 E. 42nd Street, New York 17, N. Y.

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Eighth Engineering Conference, Sheraton-Mt. Royal Hotel, Montreal, P. Q., October 26–29, 1953.

Seventh Alkaline Pulping Conference, Rice Hotel, Houston, Texas, November 18–20, 1953.

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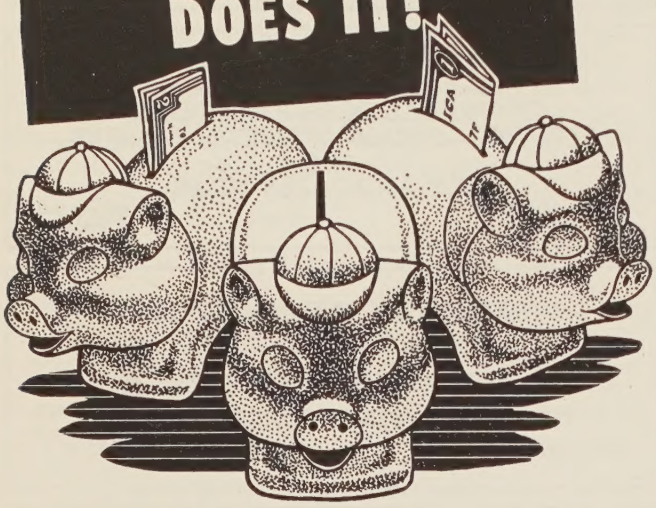

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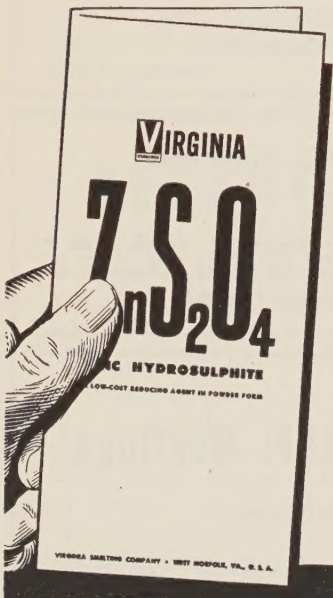

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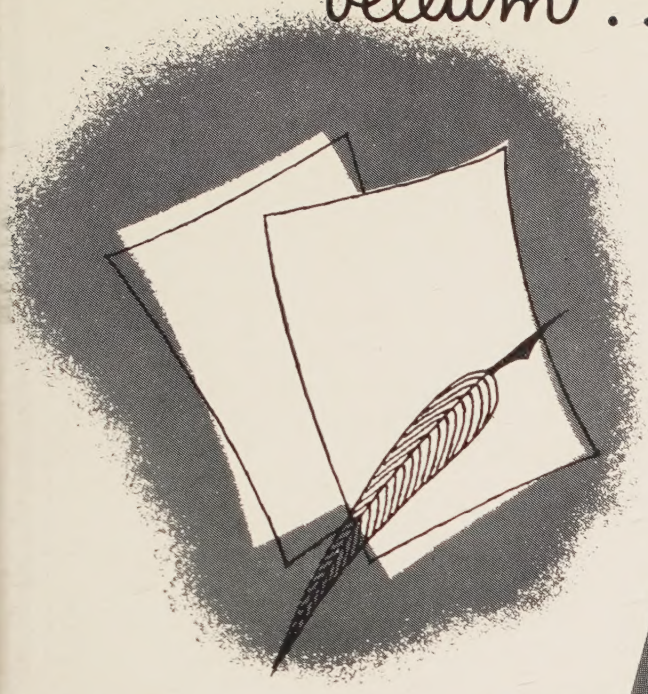

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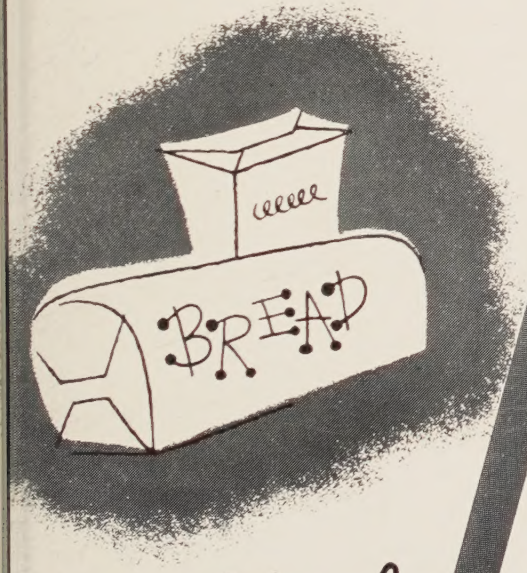

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